This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

BRANNER
EARTH SCIENCES LIBRARY

STANFORD UNIVERSITY LIBRARIES

Gift of
Chester R. Longwell

H. E. Gregory

Oct 1904

From Hotchkiss

22

C. R. Longwell
1955

GEOLOGICAL TEXT-BOOK,

FOR

AIDING THE STUDY

OF

NORTH AMERICAN GEOLOGY:

BEING A

SYSTEMATIC ARRANGEMENT OF FACTS,

COLLECTED

BY THE AUTHOR AND HIS PUPILS,

UNDER THE PATRONAGE OF

THE HON. STEPHEN VAN RENSSELAER.

BY AMOS EATON, A. M.,

SENIOR PROFESSOR IN RENSSELAER INSTITUTE, AND MEMBER OF MOST OF THE LEARNED SOCIETIES IN AMERICA.

SECOND EDITION,

With additional facts, figures and descriptions of essential organized remains, and an alphabetical list of the most important localities.

PUBLISHED

BY WEBSTERS AND SKINNERS, ALBANY;

G. AND C. AND H. CARVILL, NEW-YORK; AND

WILLIAM S. PARKER, TROY.

N. TUTTLE, PRINTER.

1832.

550
E14
ed.2
cop.2

NOTICES AND DIRECTIONS.

Having printed this Text-Book with a slow pace (it being four months in the press) I have had an opportunity to detect, and indirectly to correct, many errors. Now, having the whole before me, I can discover some defects running through the whole. A mere compiler (having been the compiler of several works, I speak experimentally,) I say, a mere compiler has, comparatively, a continued "play-day" of authorship. Though I have attempted the subject matter of this work five times before, under different titles, every attempt was almost an original effort, on account of the continued accession of facts, which I was bound to include. In this edition I have attempted a larger stride than heretofore.—The new facts collected in the last two years, since additional experience has left me fewer excuses for error, and a thorough review of the most important localities, have enabled me to fill up more chasm and to demonstrate the order of superposition in more doubtful cases, than I have heretofore been enabled to do in the same period of time.*

My first and most particular, request is; that the reader erase the note at the bottom of page 17. I regret its publication exceedingly. I wrote it under a degree of excitement, produced by the remarks of a friend; and it was in print before I took time to reflect on the absurdity of introducing such remarks, *however just*, into a text-book for youth.

---

*I have been long laying up materials for a full system of American Geology, which have filled seven blank books of the common quarto size. But, very unexpectedly, I received notice from the publishers, that the last edition was sold out, and another was demanded. And I do not regret being driven to the publication of another concise edition. In truth, I do not believe I shall ever publish a larger seytem, nor that such a system is wanted. Europeans (as Cuvier, Buckland, Bakewell, De La Beche, &c.) give us all the theoretical views required. American geologists should collect materials, essential here, and arrange them in a clear simple manner for our pupils. I believe, that I shall, from time to time, digest and abridge portions of my collection of facts for the American Journal of Science. This will be doing justice to my patron and to the public.

The article on Organized Remains was commenced without sufficient books. More books and better specimens were obtained, after part of the article was printed. In the descriptions of the plates, at the end of the book, some corrections and additions are therefore made, which must be considered as belonging to the article, which commences at page 24. When these corrections were made, and most of the article was written, I had before me Sowerby's 6 volumes, Parkinson, Brongniart's trilobites, Brongniart's fossil vegetables, Goldfuss' 1st and 2d Numbers, Miller's Crinoidea, all the articles on petrifactions published in Silliman's Journal and the transactions of the Phil. Acad. Nat. Sci. and New York Lyceum. If I have published, as new, species which are not described in these works, I am excusable if they are described in other works; because I was unable to obtain any other books. Having ventured to enter the field of American organized remains, with a view to discipline new troops for the war of rocks, I solicit the aid of better disciplinarians. I have not attempted any thing in the outer battle grounds. There Dr. Morton has already subdued all opposing forces. Our ruined Chalk rocks furnished him with such a vast supply of munitions, that he was enabled to compel the surrender of the long contested sandfields of Jersey.

The five series of regular Carboniferous, Quartzose, and Calcareous formations, which I proposed in my Geologieal Prodromus, published in the American Journal of Science in 1829, I now adopt without apology. It is founded in Nature, and must endure as long as rocks last. More than three fourths of the distinguished geologists of America have expressed their convictions of its truth, and many distinguished foreigners have yielded their unqualified assent. Let the reader turn over the pages of Conybeare, Bakewell, Brongniart, De La Beche, Ure, Woodward, and every other modern systematic writer, and he will find the Carboniferous, Quartzose, and Calcareous formations, under different names, precisely as I have stated them to be. Nothing is required but conjoining all the Calcareous rocks, which are found in contact, under the name calcareous. The Carboniferous and Quartzose are readily found, when the Calcareous is defined. The third number of M. Brongniart's Vegetable fossils most emphatically recognizes the four Carboniferous formations, above the primitive; though it is probable, that he had never read, nor heard of, my Prodomus when he wrote that article.

Teachers will never succeed without specimens sufficient for illustrating the essential characters of all strata. Lay the whole suit on a long table or board, before giving the first lecture, in the order of superposition in which they are found in the earth. Define the classes and strata, and name them over, until all the specimens become familiar to the eye and their names to the ear. Question the students around frequently on the synopsis and essential parts of the definitions or cause them to give lectures or dissertations by turns ; each referring to specimens while answering or lecturing. Illustrate all parts of the Text-book with specimens, and familiar references. But students should not be confined to reading, to specimens, and to lectures, longer than ten days. They must then be shewn the nearest rocks, from day to day, and taught to apply the proper definitions and descriptions. The Tertiary formation, the Diluvion, Analluvion, Post-diluvion, and whatever occurs near the lecture room or school, must be shewn them ; and they must carefully define every deposit.

The rambles of students must be extended as far as they can go and return the same day, and every thing carefully examined and described. Other subjects in Natural History (particularly Plants, Shells, and Insects) may be collected at the same time. Having become familiar with the nearest geological deposits, one extensive tour should be undertaken. After having taken five annual tours with students, varying the course every time more or less, I find the following to be the best and the most economical, for persons who study or reside, near any part of Hudson River.

Geological tour. 1. From Hudson River to Connecticut River, across Columbia, Rensselaer, or Washington, county. Here the primitive and transition classes, and basaltic rocks, may be advantageously studied. 2. From the Hudson River to Pucker-street on the top of the Helderberg by way of Bethlehem Caverns. Here the lower and upper secondaries may be studied. 3. From Hudson River by way of the Hudson and Delaware canal and rail-road to Carbondale. Transition and upper secondary, particularly the great coal formation, may be advantageously studied. 4. From the Hudson River, by way of South Amboy, New Jersey, to Middletown Academy. Here the tertiary formation may be studied, with the embraced Chloritic Chalk, or green-sand, of the Chalk formation. 5. Visit the transition limerock of Glenn's Falls, if convenient, and then the oolite of Saratoga. Here examine the Springs also.

Students have made all these tours with but thirty dollars expense; but it requires rigid economy. All but the Glenn's Falls tour have been made by several students of Rensselaer School, with but ordinary economy for thirty dollars. If every thing connected with Engineering, Botany, Mineralogy, Zoology, be attentively examined by students and explained by a teacher, the time (six weeks) and the money, are most profitably employed.—The number of students ought not to be under six, nor over twenty four.

In addition to the great advantages, which such tours afford to the students taking them, the cause of truth in Science is thus promoted. No Science is so much obscured by the bold assertions of the ignorant pretender, as geology. Ignorance and impudence are often companions; and readers are not always prepared to visit localities for the purpose of confirming truth or detecting falsehood. Hence the necessity of leading students to a series of localities, which afford sufficient objects for demonstrating every important principle of the Science.

This edition is printed on writing paper, with broad margins for manuscript notes, to be made by the student. But notes should be made on other paper in the field, and carefully transcribed afterwards. References to the figures may be made in the margin, against the names of the organized remains.

The geological map of the state is not to be bound in the book, because it would soon be destroyed in a travelling text-book; but it is always to be sold at the same book-store, folded in a case.

If the plan of this book would have admitted more extensive discussions, I should have taken in the investigations of Drs. E. James and Z. Pitcher, also those of Lieutenants Mather and Day, of Adjunct Professors C. U. Shepherd, and of H. H. Eaton, Mr. R. Peter of Pittsburg, and of several others. By these I could have shewn, that the Corniferous limerock, which is so widely extended over the Western States and underlaying the coal hills of that district, is the same individual rock which underlays the coal beds of Carbondale, Wilksbarre, &c. The great resemblance between the primitive rocks of Rocky Mountain, the Highlands of the Hudson and M'Comb's Mountains, could have been shewn also. They are remakably characterized, and distinguished from the primitive rocks of New England and of most European districts, by their great proportion of hornblende rocks, and by the presence of tabular spar, grains of interspersed serpentine, coccolite, colophonite, and masses of diallage.

As books sufficient for the study of organized remains are expensive, I will name all specimens, which collectors send me, excepting Bivalve-Molluscous relics. See p. 44 and 45. The following are the conditions. 1. The specimens must be fair and perfect as possible, with pieces of the rock adhering. The collector keeps duplicates of all he sends, numbered as he numbers similar specimens presented to me; and I will send him the names by letter, set in the letter against the numbers. 3. I must be at no expense for transportation nor letters; for my burdens of this kind are already insupportable.

AMOS EATON.

Troy, N. Y., June 15, 1832.

ERRATA.

These corrections must be made with the pen, before the book is read.

It is impossible to avoid errors in Scientific works, until sufficient inducements are held out to encourage a due proportion of printers to study the elementary principles of the Sciences.

Page 11, line at the bottom, change melting to meeting.
" 15, line 3, Bunce—Bruce.
" 16, line 8, Bronguiart—Brongniart.
" 31, line 9 from the bottom, *candatus—caudatus.*
" 31, line 4 from bottom, *Selenourus—Selenurus.*
" 35, line 10, seven—nine.
" 36, line 23, second—first. In Margin write *E. equicyclus.*
" 37, line 18, 2d—1st.
" 38, line 2. turbirate—turbinate.
" 42, line 8, lominæ—laminæ. /This is right
" 44, line 24, *carbosea—carbasea.*
" line 29, osthocera—orthocera.
" 51, lines 1 and 2, suppo—supported—anim—animals.
" 73, line 18, quantities.
" 78, line 2, anhydrous.
" 79, line 28, anasphaltic.
" 84, line 24, Liasoi—Liasoid.
" 86, line 3 from bottom, last word, antediluvians.
" 87, line 20, carbonate—carburet.
line 24, engiss—gneiss.
" 88, line 3 from bottom, it, before in.
" 90, line 12, overloyed—overlayed.
line 16, jury—Jura.
line 3 from bottom, calcareous.
" 94, line 3, (cherly)—(cherty.)
" 96, line 2, Feriferous—Ferriferous.
line 27, not, before quote.
line 34, gigigantus—giganteus.
" 102, line 8, fagmented—fragmented
" 104, line 1, Aluminous.
line 3, gallipot. Page 120, line 18- N. America.
line 29, liquid.
" 128, In the margin opposite to Pentacrinus fimbriatus, write *P. subangularis, P. basaltiformis,* Miller. Found in 3d graywacke (oolitic formation) in Seneca county, by Mr. W. H. Boyd, a student in this school.

GEOLOGICAL TEXT-BOOK.

CHARACTER AND OBJECTS OF GEOLOGY.

The science of Geology consists in a systematic arrangement of facts, explaining the structure of the earth.

Our observations are limited to its exterior rind or coats. We know very little of its interior structure. But the inequalities of its surface often give us admission to a considerable depth; from which we should be totally excluded were its surface every where smooth like a pacific sea.

Since the earth's specific gravity has been ascertained by suspending the plumb-line by the side of an insolated mountain rock, we infer that it must be made up of heavier materials interiorly than near its surface. For the whole mass of the earth is found to weigh about five times as much as an equal mass of water. Whereas all its exterior rind, from the surface to its greatest ascertained depth, taken in the aggregate, weighs but about half as much. Late experiments by Cordier and others, seem to lead us to important conclusions respecting the internal temperature of the earth. It is proved, that as we penetrate the earth, the temperature diminishes until we are below the limit of solar influence. And from that point the temperature increases at the rate of about one degree of Fahrenheit for every fifty feet. But it is not probable, on any hypothesis, that heat increases in this ratio to the centre of the earth. If it did, the whole interior of the earth would be in a state of melted lava; leaving, according to Cordier, a solid crust less than one hundred miles in thickness—not exceeding in proportion the thickness of an egg-shell.

As numerous observations seem to prove, that the surface of the earth is of a lower temperature than formerly, it may be in accordance with analogy to suppose, that the cooling of a heated cannon ball will exemplify the gradual cooling of the earth. Therefore, as the cannon ball cools rapidly at its surface, without any material diminution of temperature at the depth of an inch for a long time ; we may infer that after penetrating the earth to the depth of a few miles, we should arrive nearly to its maximum of heat.

Specific gravity and internal heat being all we know of the structure of the earth, excepting what we learn from inspecting its surface, the absurdity of ancient theories is manifest. But the tops of the most elevated ridges being about five miles higher than the deepest natural and artificial cavities, much has already been ascertained respecting the history and structure of the earth.

Geological facts lead us to the history of created beings, long anterior to written records. Such records may be erroneous, and we have no means for correcting them. But geological records are perpetual, unvarying, and cannot be vitiated by interpolations or counterfeits. For example : the written history of the deluge might be varied more or less by erroneous copies or incorrect translations. But the geological records of divine wrath poured out upon the rebellious inhabitants of the earth, at that awful period, can never be effaced or changed. These latter records add, to the Mosaic account, that even the antediluvial beasts of the forests and fens partook of the ferocious nature and giant strength of antediluvial man.

The order of creation too is stamped upon the everduring rocks. There and there only we learn which of the grasses and of the herbs yielding seed, and of the fruit trees yielding fruit after its kind, was created first. For the acotyledonous tribe of ferns first appear in the oldest rocks containing organic relics ; these are followed by the largest mono-cotyledonous tribe of grasses, canes and reeds. Here too we find the first created fruit-tree yielding fruit to be the ancient palm. No records but the geological could ever have brought to our knowledge the known truth, that no cauline or dicotyledonous plants were created, until all rock strata were finished; and that man was created later than cauline plants.

Whoever feels an interest in the works of creative intelligence, must be delighted to trace those works from that early period of time which is far beyond the highest recorded limits of antiquity. This enrapturing pursuit is within the reach of none but the geologist.

Geology teaches us that minerals which are associated in one district of country are associated in the same order in all other districts. Hence the experience of the miner and the quarry-man in any country may be applied in searching for useful minerals in all countries. But here the aid of the scientific geologist is necessary; for *geology is ths true science of mining.* As in all other cases of the kind, the facts which accident presents to the artist, must be collected and generalized by the man of science; and then presented to all artists of the same profession. For example, the discoveries of gold in the talcose slate of the Carolinas, will serve as an index to the miner, pointing to the whole range of talcose slate from Georgia to Canada, by way of New-York and Green Mountains of Vermont.

From the general composition and character of every kind of detritus, we are enabled to judge of the fertility of soils, and to apply correctives in cases of barrenness. For example: whenever we find marine sand, which is now known to be a very extensive stratum, we can always find the marley clay beneath it. This will induce the agriculturist to apply an efficient corrective for improving his barren sands, by raising the marley clay from pits, and applying it to the surface as his situation may afford the means.

Mountains, valleys, beds of oceans, seas, lakes and rivers, are all referable for their origin to geological changes. The soft saliferous and carboniferous rocks, in which the bed of Lake Ontario is made by the rapid disintegration of those rocks, is an example. The beds of Lake Champlain, the Mohawk river and of the Hudson through most of its extent, were made by the disintegration of rocks at the ~~melting~~ of different formations.

meeting

The deep bed of the Hudson across the Highlands, which is chiefly hornblende rock, may, without extravagance be ascribed to the fusion by volcanic heat which produced the basaltic Palisadoes below the chasm. The same hypothesis may be well applied to the channel of Connecticut river, north of the northern line of Massachusetts, whence the volcanic lava flowed which now forms a series of basaltic prominences from Vermont to Long Island Sound. Hence one important part of Physical Geography may be explained by a reference to disintegration, decomposition, volcanic action, and other geological agencies.

CONCISE HISTORY OF GENERAL GEOLOGY.

The name geology was originally applied to visions, which floated in the fancies of men, respecting the original productions of the earth. No facts were adduced in proof of hypothesis, excepting the few which presented themselves to, or rather enforced themselves upon, the senses, without the labor of research. *Possibility*, without even the shadow of *probability*, seems to have been received as conclusive evidence.

We are indebted to the Germans for geology as a science. Lehman first published the fortunate suggestion, which elevated geology to the dignity of a science. He first called the attention of the learned to a view of creative intelligence in the systematic arrangement of the solid contents of the apparently amorphous earth. The illustrious Werner improved upon the thought. Through a long life, by uniting study, theory and practice, and directing all the energies of his mind to a single object, he gave character and great interest to this department of nature. He led his numerous pupils into the hitherto dark regions of the earth, which his mighty genius had then illuminated. Though he was somewhat bewildered by the mazes of fancy and yielded too far to the visionary theories of his time, his classification of facts must ever form the basis of all future geological enquiries.

Saussure, De Luc, Humboldt, Kirwan, Jameson, and others, improved upon Werner by the aid of additional facts. These facts Werner lived to apply as correctives of his early mistakes, and to fill up the chasms in his own discoveries. He closed his long life in the full splendor of his scientific glory, in the same year (1817) in which we began to make our humble efforts in the application of his views to American earth.

Hutton had done much in the lifetime of Werner. But his theoretical views were at variance with those of Werner; and much overheated controversy existed between their respective pupils. Werner ascribed most geological phenomena to the agency of water, while Hutton referred the same to the action of internal heat. Hutton died in an unhappy state of mind, at a time, when his views were almost universally rejected; but Werner died amidst the universal plaudits of his favorite views. Scarcely had the earth, which he had studied with such interest and applause, received his manes when his theory was reviewed, and began to be received with less approbation.

At length the illustrious Cuvier came before us. He balanced the two theories with a giant hand. He demonstrated the Huttonian theory in its application to many phenomena; but left much to be explained upon the Wernerian. He relied solely on well established facts, and proceeded cautiously in his theoretical views. Bakewell, Brongniart, M'Clure, M'Culloch, Greenough, Phillips, Conybeare, with numerous others, constituting a brilliant constellation of resplendent luminaries, now began to enlighten both subterranean hemispheres; while the *very exterior surface* of the earth was scarcely considered.

Such was the general state of geological science at the close of the first score of years in the present century. Since that time Buckland, aided by the veteran Cuvier, has commanded the whole geological phalanx to leave for a while the deep abodes of rocks, and to examine "the open caverns and the furrowed earth." He has led out before us, from the cave of Kirkdale, the antediluvial elephant, chased and gnawed by hundreds of hyenas, who had dragged it in, peacemeal, through a comparatively minute aperture. He has shewn us the torrid abodes of the river horse and the elephant to have been in the latitudes of Caladonia and Scythia. The deluge no longer rests on the authority of written evidence. He points to records as durable as the earth, and far less changeable. The study of organized beings has, consequently, become the most essential qualification for the study of geology ; for their relics are the indelible records of truth, susceptible of no interpolations.

But in the midst of these splendid discoveries, which overwhelm the strongest imagination with wonder and amazement, some reformation seems to be required, even among those rocks where Lehman and Werner began their labors. This humble task has occupied many a weary hour of the author of this attempt at guiding the young mind in the study of nature's earliest labors.

PROGRESS OF AMERICAN GEOLOGY.

" By what authority does this author attempt to teach us," is a *mental* question at least, whenever we open a book, professing to communicate instruction. If the author gives us no answer in his preface, we accuse him of *presumption*. If he gives us his reasons for believing himself qualified to teach us, we accuse him of *egotism*. I shall choose the accusation of egotism ; and shall merit it, in some measure, by confining my views of the progress of American geology to that field in which I have been a continual laborer. I believe it will be conceded, that I have devoted *more time and labor* to American geology than any individual, and under the most favorable auspices—I mean through the patronage and munificence of General Stephen Van Rensselaer.

The progress of geology in America may be divided into two eras. First, McClure's surveys for establishing our Geographical Geology. Second, Van Rensselaer's surveys for establishing our Stratiographical Geology.

About the beginning of this century, Dr. Mitchell of

N. York, began to instruct his classes in Kirwan's views of Geology, occasionally illustrating them with foreign and American specimens. Dr. ~~Busee~~ Bruce took a part in it, as appears by his journal. Very little progress was made in the science, however, for want of a connected series of observations. The science of geology can never succeed in any country, until transverse surveys are taken across extensive districts.

First era of American Geology—McClure's surveys for establishing our Geographical Geology.

McClure did not attempt a classification of Amercan rocks. In his treatise he published the Wernerean names, but did not attempt a detailed application to our strata. His geographical view of the Primitive, Transition, and Secondary, classes of Werner, in the United States, has been shown, by future examinations, to be *astonishingly* correct; when we contemplate the magnitude and extent of the undertaking.

McClure's labors were followed by numerous attempts, at descriptions of limited formations; which appeared in the transactions of societies and temporary journals. For want of a connected series of observations, comparing strata and noting their order of superposition, most of those descriptions and essays were erroneously referred to the Wernerean system.

After the arrival of the splendid cabinet of Colonel George Gibbs, which was loaned to Yale College, Prof. Silliman gave his annual course in that cabinet to the students of that institution. Want of time prevented his making extensive comparisons with the specimens of the cabinet, for the purpose of applying Wernerean names to our rocks, during several of the first years of his lectures. His investigations of this kind were mostly limited to Connecticut, Rhode Island, and Massachusetts. Students, in their returns after vacations, brought him rock specimens from various parts of the continent, West India islands, &c. But every experienced geologist knows, that specimens collected in localities, between which no connexion has been traced, afford but little aid towards ascertaining the order of superposition.

Having previously examined the Highlands on the Hudson, Catskill Mountains, Green Mountains in New England, &c. by the aid of Kirwan's descriptions, I put myself under the direction of Prof. Silliman, in the year 1816. I attended two of his courses of lectures in Mineralogy and Geology in Gibb's cabinet, and a course on Chemistry. In his lectures he illustrated the Wernerean system, as improved by Cuvier, Brongniart, Bakewell, and others, with the aid of foreign specimens--occasionally introducing such collateral specimens from our own rocks, as he had examined in place with sufficient care. But his American specimens were chiefly Primitive, Basaltic, and Tertiary (though the latter name had not then been introduced.)

Having received an invitation to aid in the introduction of the Natural Sciences at Williams College in Mass., I commenced a course of lectures at that institution, in March, 1817. Prof. Silliman had furnished me with an outfit of the most important specimens, which, added to my own collection, and a collection made by Prof. Dewey of Williams College, I was enabled to commence my course of instruction to good advantage, considering the low state of the Science in this country. Such was the zeal at this institution, that an uncontrolable enthusiasm for Natural History, took possession of every mind; and other departments of learning were, for a time, crowded out of College. The College authorities allowed twelve students each day (72 per week) to devote their whole time to the collection of minerals, plants, &c. in lieu of all other exercises. Several members of the institution, who commenced their studies at this period, became eminent Geologists, Mineralogists, and Botanists. Professors Dewey and Emmons, were of the number.

At their return after the spring vacation, students put me in possession of numerous specimens of almost every rock in Massachusetts and the adjacent parts of Vermont, N. Hampshire, and N. York, accompanied with written descriptions of their localities and some of their associations. With the aid of these specimens, and two tours which I made from Boston across Massachusetts and the east part of N. York as far as Susquehanna River, I made the first attempt at a systematic arrangement of American rock strata. I followed the Wernerian arrangement, as improved by Bakewell and illustrated by Silliman, as nearly as possible. But I could not satisfy myself of the existence of Werner's granite, excepting as an alternating layer or vein in gneiss or hornblende rock; though I introduced it on foreign authorities. Our argillite could not be arranged according to Werner; but Bakewell's opinion seemed to clear up the difficulty in some measure. The limits of transition rocks were not well defined, and the secondary were not understood. With these, and numerous other imperfections and some visionary conjectures, I published my imperfect classification of American rocks in a pamphlet of 41 pages, under the title, " An Index to the geology of the Northern States of America." It was accompanied with a rough leaden plate, exhibiting a transverse section, of the rocks from the Atlantic ocean to Susquehanna River.

The friendly reception which this coarsely executed pamphlet met, was truly gratifying; and proved that the undertaking was well-timed. It was honored as the battle ground, whereon the devotees met to contend in the warfare of the science, with zeal and good feelings. It is a curious fact, that, notwithstanding the diversity of opinion which existed among American geologists on numerous points of enquiry, no collision of feeling, not a word, not a thought, has ever appeared among them, calculated to disturb the harmony necessary to the progress of the science. Foreigners* too have held out the hand and tendered us their friendly aid to guide our tottering steps.

---

* I would except the few foreigners (self-styled geologists) who have come among us, and have endeavored to excite feuds, without success. These came to this country totally ignorant of the science; but having caught a mere smattering from our geologists, they began to "hail from Europe" as wonders there. As such they obtained admittance for their scurrility in some of our journals "of easy virtue;" though no distinguished European geologist will acknowledge them, or ever heard of them as geologists.

Soon after I had published the pamphlet alluded to, Prof. Silliman issued the first number of his American Journal of Science. His notice, of my attempt to collect and generalize geological facts in this country, seemed to be very acceptable ; for about eight hundred copies were retailed in sixteen months. Another edition was published in the winter of 1820, in a duodecimo form, under the immediate direction of the Troy Lyceum of Natural history.

In April 1818, I went to Albany on the special invitation of Gov. De Witt Clinton. He headed a subscription with his name for a course of lectures on Natural History, to be given by me in Albany ; and Dr. James had procured the signatures of many principal citizens, before I arrived. In Albany I found Dr. T. Romeyn Beck, and in Troy, Doctors Burrett, Robbins, and Hale, zealous beyond description in the cause of Natural Science. By the exertions of these gentlemen a taste for the study of Nature was strongly excited in these two cities ; especially for that of geology, They, together with several others, had become members of the New York Lyceum of Natural History ; and in the fall of 1818, established a society of the same name and upon a similar plan, in Troy. Collections were made with such zeal, that in the course of a few months Troy could boast of a more extensive collection of American geological specimens, than Yale College, or any other institution on this continent. In the winter of 1819, through the exertions of Dr. Beck, seconded by Gov. Clinton, the Hon. Simeon De Witt, and the Hon. Saml. Young, I was employed in giving a course of lectures on Geology and Chemistry with their applications to agriculture, before the members of the legislature, in the rooms of the Society of Arts in the Capitol. This event gave me an opportunity to attempt a general diffusion of a taste for these subjects throughout the state. In truth a thirst for the Natural Sciences seemed already to pervade the United States, like the progress of an epidemic.

Though I introduced into the second edition of the

"Index to the Geology of the Northern States," many improvements, it was still very deficient in the secondary class; and the Tertiary was unknown. Hayden's treatise, and Schoolcraft's travels, contained a collection of facts, sufficient to elucidate the tertiary and diluvial formations; but the present views of these subjects had not then been taken. In this edition I introduced a translation of the Linnean descriptions of organized remains, as improved by Martin. Le Sueur having labelled a small collection, chiefly from the Helderberg in Albany county, we were enabled to make some progress in that department of geology. It will not be consistent with the design of this article to acknowledge all the sources from which I derived the materials employed in making up my views of American Geology at that time. The contributions made to the two first volumes of the American Journal of Science were all consulted in preparing the 2d edition of the Geological Index.

Second era of American geology—Van Rensselaer's surveys for establishing our Stratiographical Geology.

I consider 1820 the closing year of the first era, and the comencement of the second. Numerous insulated facts had been collected and some progress made in the Stratiographical geology of the New England States; but no attempt had been made at a general arrangement of the secondary strata of the state of New York, or any of the western states.

It is a curious fact, that every western stratum in New York had been misnamed in the published accounts of them. A ridge on the south side of Lake Ontario, which is the outcropping edge of a red sand-rock, thinly covered with detritus, had been treated as post-diluvion, washed up by the Lake. This was adduced as a record of the once elevated surface of the lake. In truth, every thing that had been done relating to our Western geology, was calculated to mislead.

In the summer of 1820, Dr. T. Romeyn Beck of Albany (who has done enough for science to elevate, high in the scale of fame, a dozen ordinary men) laid before the Hon. Stephen Van Rensselaer, a plan for investigating the geology of North America. By attending to the north and south ranges of our rock strata, it appeared manifest, that a transverse section from the Atlantic Ocean near Boston, to Lake Erie, would, probably embrace every important formation. No act could have been more disinterested. For though he was himself devoted to the science, and his younger brother had made considerable progress in it, he reserved nothing for himself or his particular friends; but proposed that the superintendence of the undertaking should be placed under the direction of whoever had been most conversant with such investigations. The plan pursued at the expense of Mr. Van Rensselaer, was the following.

A particular survey was taken of the two counties lying in the direction of the Erie Canal in the state of New York, adjoining the west line of Massachuseetts—to wit, Rensselaer and Albany counties. The most necessary experience was thus afforded for qualifying the superintendent for entering upon a survey of the Erie Canal line. These surveys were commenced in the summer of 1820 and pursued with great diligence through four summers; and at least one tour, (and often four, five, and more) along the line has been made by the superintendent every year until 1830 inclusive. In January, 1824, a report was made to the Patron, accompanied by a profile view of the rock strata from the Atlantic to Lake Erie; a distance east and west of between five and six hundred miles—also a profile section extending from near the west line of Massachusetts to the Atlantic, drawn and explained by Prof. E. Hitchcock. The report and both views were published by the Patron. The report occupied 163 oçtavo pages. It being the first, and only, attempt at such an extensive survey of this kind, hitherto made in any country, it excited considerable expectation. As it has been fully before the public for eight years, its character for accuracy is probably settled.

Since the first report was published, numerous reviews and corrections have been made, and numerous other surveys taken at the expense of the same Patron. Upon these surveys (which have occupied a greater or less portion of eleven summers) added to the previous observations of five years, the principles adopted in this text-book, are chiefly founded. Many of them are confirmed by the labors of others; most of which may be found in the Am. Jour. Sci. These and others will be included in the Alphabetical arrangement of localities in the last part of this book; where I hope to do justice by careful references. For I most cordially adopt the sentiments of Cuvier, which are thus expressed: "No property should be held more sacred, than the conceptions of the mind. The practice of covering plagiarisms under a change of names, has always appeared to me to be highly criminal."

As the preceding recital of those facts, which have had an influence on the progress of geology in this country, brings the subject within the recollections of the present race of young geologists; I shall not detain the reader with an account of the rapid strides, which the Science is now taking. Cuvier, Buckland, Brongniart, Bakewell, and other giant veterans, are still in the field; while an army of young invincibles are bringing up the rear, who seem to threaten ignorance and charletanism with total extermination.

The application of the labors of foreign geologists who were in the field before us, has occupied most of our time and attention. And we have been rewarded by finding equivalents for almost the whole of their *well defined* strata. We have often been misled by the opinions their lazy theorists, who preferred the well-turned periods of the closet to laborious research. And the limited extent of some strata, especially in England, has misled their most diligent enquirers, and, consequently, has embarrassed us.

It will be in accordance with the object of this article, to refer to some of the discoveries made be the agents of the Hon. Stephen Van Rensselaer, which were not observed by foreign geologists.

1. That each of their own classes, as well as ours, is always commenced with carboniferous slate, and terminated with calcareous rocks ; having a middle formation, whose center is quartzose.

2. The discovery of a Ferriferous stratum, containing the argillaceous iron ore, both compact and lenticular. In Europe, this had been observed in very limited beds—here we find it in a stratum more than two hundred miles in length. It extends, unbroken, from near Utica to the extreme termination of Lake Ontario, in Upper Canada.

3. That bog-ore, proper, belongs to the tertiary formation ; and that it is, in greater or less quantities, co-extensive with the Marly clay (London clay) and Marine sand.

4. That talcose slate is the grand repository of hematitic iron ore, per-oxyd of manganese, and of gold in nearly a pure state.

5. That the Corniferous limerock is the true carboniferous, only. And that it is separated from the Metaliferous, or upper transition, in some localities, and rests upon it in others. But that it is always totally distinct ; both on account of embraced organic remains, and its relative superposition, when the lower secondary strata are all present.

6. That crystalline granite (granite proper) is not entitled to a place among general strata ; as it is never found, other than as a bed or vein, where we have an opportunity to examine it extensively.

7, That granular quartz and granular limerock are entitled to a place among general strata ; as we have traced them, unbroken, more than five hundred miles.

8. That all primitive rocks, excepting granular quartz and limerocks, are cotemporaneous ; for they alternate continually, by their entire masses, through a breadth of one hundred and twenty, and a length of more than four hundred, miles. We have considerable evidence of their extension from Hudson's Bay to the Carolinas.

9. That there is evidence of a diluvial stratum having been deposited near the termination of the deluge, which formed an universal mantle about the earth. And that it is still manifest on elevated plains, which have not been since changed by strong currents, nor deprived of their ancient forest trees.

I close this article by advising those students, who have graduated at this school, to read the American Journal of Science, as the numbers appear. It is truly *the Journal of Science.* In it we find a record of the daily progress of scientific knowledge in every part of the world. All its volumes taken together, exhibit the progress of science in this country from infancy to manhood. The American editions of Bakewell, Cuvier, and De La Bache, are not expensive, and ought to be read attentively.

ORGANIZED REMAINS,*

AS AUXILIARIES IN THE DETERMINATION OF ROCK STRATA.

The remains of similar species of animals and plants are found embraced in similar series of rocks; and these occurrences are so uniform, that rocky and earthy strata may be determined by them. The animals were mostly of very simple structure, without brains; as oysters and corals. The plants were mostly destitute of blossoms; as grasses and ferns. The latter indicate coal deposits, only.

As the remains or impressions of plants, are limited to coal and coal-formations, whose relative position is indicated by their rocky associations; the determination of rocks by their animal relics, serves as an index to the position of coal measures or beds. In this concise selection of the most essential relics, *animals alone* will be noticed, which have no back-bones nor brains.

Animals of all classes are found in a state of preservation, which the geologist may have occasion to consider; consequently a geologist *ought to be* a zoologist. A concise view of the general principles of classification will therefore precede a description of the species of invertebrated animals, selected for this text-book.

Animals are either *Vertebral,* having back-bones and brains; or *Invertebral,* without back-bones and brains.

FIRST GRAND DIVISION IS VERTEBRAL.

I. VERTEBRATA. Having back-bones and brains. These are distributed into four classes. *Class* 1.—Mammalia, *viviparous, food of the young being the milk of the dam.* Ex. *Bimani,* (two-handed) man. *Quadrimana,* (four handed) as ape. *Carnaria,* (flesh eaters) as bat, hedge-hog, mole, bear, weasel, dog, cat. *Marsupialia,* (pouch animals) as opossum, pouched rat.—*Rodentia,* (gnawers) as squirrel, mouse, beaver. *Eden-*

---

* See figures, and references to names, at the end.

tata, (without fore teeth) as armadillo. *Pachydermata*, (thick-skins) as elephant, hog, horse. *Ruminantia*, (cud-chewers) as camel, deer, sheep, ox. *Cetacea*, (whale-like) as porpoise, whale. 2d CLASS, AVES, *oviparous, and hatched by the dam.* Ex. *Accipitres*, (hawk-like) as vulture, owl, hawk. *Passerina*, (sparrow-like) as lark, robin, swallow, crow. *Scansoria*, (climbers) as parrot, woodpecker. *Gallinacea*, (hen-like) as peacock, partridge, pigeon, hen, turkey.—*Grallatoria*, (long legs) as ostrich, crane, heron. *Palmipedes*, (palm footed) as duck, goose, pelican. 3d CLASS, REPTILIA, *mostly oviparous, without being hatched by the dam, cold-blooded and amphibious.* Ex. *Chelonia*, (tortoise-like) as common turtle or tortoise. *Sauria*, (lizard-like) as crocodile, chamelion. *Ophidia*, (serpent-like) as striped snake, rattle-snake. *Batrachia*, (frog-like) as toad, bull-frog, salamander, proteus, siren. 4th CLASS, PISCES, (fish) *oviparous, without being hatched by the dam, having fins and scales.* Ex. *Bony fishes*, as shad, pike, common eel. *Cartilaginous fishes*, as sturgeon, shark, saw-fish, torpedo, ray, lamprey eel.—Fish have been observed in North America, in green-sand, marly slate, and bituminous shale.

THE THREE REMAINING GRAND DIVISIONS ARE INVERTEBRAL.

II. MOLLUSCA. Having no skeleton, but the muscles are attached to a soft, contractile skin, as the slug (naked snail). Many species have stoney plates for covering, called the shell, as oyster, clam. Shells are in one piece, called *univalve*—in two pieces, called *bivalve*—or in more than two pieces called *multivalve.*

III. ARTICULATA. Having the tegument of the abdomen in jointed rings. The animals are, *Crustacea*, covered with a crust; as lobster, trilobus, crab—*Arachnides*, spider-like; as spiders, grey-beards—*Insecta*, proper insect, as wasp, locust, ant—*Annelides*, jointed worms, as leach, shell-worm.

IV. RADIATA. Having the organs of sense and motion disposed like rays around a centre. The animals are *Echinodermata*, (prickly skin) as star fish, sea urchin, wheel-whirls—*Polypi*, (zoophytic or animal plants) as the occupants of various corals, &c.

Remarks. References are frequently made by geologists, to the remains of animals in all the four grand divisions; but for the mere determination of strata, I propose about 60 or 70 species of organized remains, selected from the following families.

1. From the *Mollusca*, the Nautilite, chamber conks; and Helicite, snails. 2. From the *Articulata*, the Trilobite, paradoxes. 3. From the *Radiata*, the Crinoidite, wheel-whirls; Cyathophyllite, stone horns; Madreporite, tree corals; Tubiporite, column corals; Fungite, mushroom corals; Gorgonite, fan corals; Reteporite, net corals.

*FROM THE MOLLUSCA.

The *Nautilite Family* embraces univalve molluscous animals, whose shells are divided into chambers by transverse partitions. When the shells are in coils, they are called Nautilus, Argonaut, Ammonites, Bellerophon, &c.: When straight, they are called Orthocera, Belemnus, &c.

Genus Nautilus. Shell univalve, divided into chambers or cells by transverse partitions; the chambers are connected by circular windows, or apertures, called siphunculi.

N. imperialis, involute, umbilicate; aperture lunulate; partitions entire, concave, and in undulations broadest in the middle: umbilicus open. Best known by the centre of its coil being open. Found in the marly clay of New-Jersey, and in the same stratum in Highgate, England. I have an outside specimen, and an interior casting of green sand, which I found embraced in New-Jersey marly clay.

---

* About 1200 species of organized remains are now proposed for preparing students for the study of geology. Fair trial will decide, whether my assertion is correct—"less than 100 species are sufficient for the *geologist*; though the general naturalist should not content himself with that number." American geologists are called on to decide; keeping in view American strata only. I am willing to stand committed in the affirmative. But being limited, in this edition, wholly to specimens observed *in situ* by myself, and being liable to some displacements, I solicit corrections and aid.

GENUS BELLEROPHON,* Montfort. Univalve, involute and sub-spherical; aperture arched, terminated by the extremities of the transverse columella, (axis) and furnished with a sinus in the centre of its outer edge—as the aperture is rarely manifest, other characters must be considered—the body, like the argonaut, did not extend to the inner side of the spire; hence transverse partitions were limited to near the aperture—impressions of the transverse partitions are rarely manifest; outer whorl very thick.

B. volutus,† mihi, (scroll trumpet) coils about two, compact or closed, with the apex ascending, or elevated above the plane of the upper side, resembling the scroll of the architect; the whole presenting an oblong form. The inner casting is common in shell grit, lying on the cherty limerock, in Helderburg, one mile east of Pucker-street.

B. convolutus, mihi, (spiral trumpet) coils about two, compact or closed, with the apex nearly in the plane of the upper surface; the whole presenting a circular form. Found with the preceding, but not so common.

B. cornu-arietis, Sowerby, (stone ram-horn) coil between one and two, open and the coils not touching each other. Found with the preceding, but rare.

GENUS ORTHOCERA,‡ (straight stone-horn). Univalve, straight or nearly so, transversely marked with the impressions of partitions, whether outer specimens, or inner castings; gradually tapering towards the apex in some species, and rapidly in others; partitions more or less distant, even edged, circular, transverse, undulated and zig-zag; windows, apertures, or siphunculi, between chambers, are near one side.

---

* This was the name of a famous conqueror by sea and land, according to ancient Mythology. Among other achievements, he captured a boat from a pirate, which he afterwards navigated. It resembled the celebrated boat Argonaut, from which the genus Argonaut was named, on account of the form of the shell—so this petrifaction was named Bellerophon, for a similar reason.

† I give descriptive names to this species and the next, because they are not described in Sowerby, nor in any books in my possession. If they have been described, let my names be used as descriptive adjectives.

‡ This name is a contrast of Cornu-Ammonis, (horn of Jupiter Ammon) which is coiled; it being a straight horn, *orthos*, straight; *keros*, horn. Ammonites is a common genus; but I have not located any definite species.

O. circularis, gradually tapering, round-cylindric; partitions very concave towards the base, with even edges; windows intermediate between the center and one side. My specimens may be a new species, for the partitions are double the distance, from each other, of that of Sowerby's figures. This and the three next species, were collected at Lake Huron, and presented by Gen. Peter B. Porter; all in one fragment of the rock.

O. striata, tapering very gradually to an obtuse apex, longitudinally striated, probably thin; aperture oval, one third broader than wide; partitions numerous, deep. Very large—sometimes 15 feet long.

O. undulata, [if figured in Sowerby] shell ovate, thin, smooth; partitions numerous, oblique, edges rising, oval, with an undulation on each side; window near the upper edge.

O. annulata, slightly tapering, gently compressed, with strong annular undulations, and minute transverse undulating striæ, undulations a little oblique.

O. conica, terete-conical, window oval, (a little wider one way than the other) smooth; chambers numerous, increasing in depth by age. In 2d graywacke, or slaty lias, at Cold Spring.

O. paradoxica, lanceolate, curved, somewhat three-angled, with a flat front and convex sides; aperture an equilateral trough; windows nearly central. Approaches the Nautilus in character. This may be a new genus. Sowerby had seen but one specimen.—It has no spire, but is clearly an orthocera. In cherty limerock at Bethlehem caverns.

Helicite Family embraces all the modern genera, into which the genus Helix, of Linnæus, has been divided. The animal is truly a *limax*, as Linnæus named the naked snail or slug. But this family embraces those kinds of limax only, which inhabit univalve, *unchambered* shells, which are spiral, gibbose, more or less flattish at the bottom, having the aperture more or less contracted, semi-lunar or roundish. Cuvier says, "the aperture of the shell encroaches more or less upon the projection of the next to the last whorl, so as to give it a crescent-like form."

GENUS HELIX. The crescent aperture as wide as it is high, or wider; the whole shell sub-hemispherical, with the apex elevated considerably above the plane of chief portion of the animal. The common snail, (H. albilabra) belongs to this genus. No species of it is necessary according to the plan of this text-book.

GENUS PLANORBIS. Aperture wider than high; apex not elevated; convolutions nearly in one plane, forming an *orbicular plane.*

The species P. obtusus, P. albus, P. paludosus, P. annulatus, I have found in shell-marl.

GENUS LIMNEA. Spire oblong, extended to considerable height above the large gibbose whorl: aperture higher than wide; shell thin. Found associated with Planorbis.

The species L. longiscata, L. minima (probably a young variety of longiscata), I have found in shell-marl. The L. longiscata is often 2 inches long.

Cuvier says, that the presence of these, and some other species, in shell-marl, proves it to be a fresh water deposit. It was not convenient for me to figure and describe these species, neither is it necessary, as shell-marl can never be mistaken.

FROM THE ARTICULATA.

* *Trilobite family* embraces those crustaceous animals,

the transverse articulations of whose abdomens are crossed by two series of grooves, depressions or undulations; so that the whole animal presents a three-lobed, or three columned appearance, longitudinally.

---

* Brongniart, in his excellent "Natural History of Crustaceous Fossils," refers them to *crustaceous articulata.* Latreille refers them to the Chiton family of the *multivalve mollusci.* I was inclined to Latreille's opinion, until Dr. James Eights, of Albany, brought home a collection of crustaceous animals, made by himself in the Southern Ocean. Assuming Brongniart's definition of a trilobite, Dr. E. has certainly two species (and I am inclined to believe he has three) trilobites, which are now living in those seas.

I have described the Calamena and Asaphus of Brongniart, and proposed Brongniartia and Nuttainia. The two latter appeared to be necessary, as we have several species which cannot be referred to Brongniart's genera.

The following species are selected for American students in Geology.

GENUS CALAMENA. Body contractile into a spherical form; before contracting it is nearly semi-cylindric; the head, or buckler, bears tubercles, two of which are eye-form and reticulate; the abdomen is divided into 12 to 14 articulations.

C. blumenbachii, (Dudley fossil) buckler round, with 6 distinct tubercles in front; eyes on the elevated cheeks; body tubercled. Called also Trilobus imbricatus. Glenn's Falls in transition limerock.

GENUS ASAPHUS. Body large, somewhat flattened; middle lobe projecting and distinct; lateral lobes each greater than the middle one; buckler semi-circular; tubercles reticulate, eye-form; abdomen with 8 to 12 articulations.

A. hausmannii, tail rounded and forming the middle of circular arc, whose centre is in the fore abdomen, near the head; covering tubercled or spined. Found in coral rag on the south shore of Lake Erie—also, in its underlaying grit slate, on the Helderberg.

A. ca~~n~~udatus, tail prolonged, acute; buckler roundish before, emarginate behind, with its external angles extended into mucronate points; eyes exsert, conic, truncate, distinctly reticulate. Glenn's Falls, in transition limerock.

A. selenurus,* mihi, tail crescent-form, or concavo-convex, with the convex side forward, upon which the post-abdomen terminates; abdomen contains about 12 articulations, with an abrupt termination equal in breadth to one fourth of the length of the transverse lunulate tail; the articulation of the side lobes gradually incline towards the axis of the body, until the last pair terminate on the tail. Found in transition limestone at Glenn's Falls and Becraft Mt., near Hudson. I have a specimen from Becraft Mt., with part of the original covering of the animal remaining.

---

* *Selene*, moon; *ouros*, tail.

Remark. In all the figures given by Brongniart, excepting a part of those under Paradoxides, he makes the articulations of the side lobes differ *in number* from those of the middle lobe. And *in all cases* makes two deep grooves or furrows at the places of meeting. His words are—*par deux sillons profonds*, (by two furrows deep), see p. 3. We have in this country at least three distinct species, wherein the side lobes are separated from the middle lobe by mere *undulations* in the articulations of the abdomen. With due deference, which, *in this case*, I feel, I venture to propose a new genus, founded on that character.

GENUS BRONGNIATIA.* Mihi. Fore abdomen always, and post abdomen in some cases, longitudinally divided into three lobes, by regular series of undulations traversing the joints, without grooves; articulations of the side lobes being manifest continuations of those of the middle lobe, and consequently, agreeing in number.

B. platycephala, head and fore abdomen very broad and depressed, the abdomen with ten joints, curved forward at the undulations; post-abdomen and tail with about 15 joints, curved backward at the undulations; the three lobes of the tail more distinctly separated: divisions between the joints of the abdomen double.—Found in soft slaty lias. A figure of the head and 8 joints of the fore abdomen of this species was given me by Mr. G. W. F———h, two or three years since. He said that Dr. Bigsby found the specimen on St. John's Island, in Lake Huron; and that it had been published under the name, Asaphus platycephalus. I have before me two specimens from Lockport, on the Erie Canal, presented by Dr. Smith of that place.—The whole animal was six inches long and three broad. Ogyges latissimus, Am. Jour. Sci. v. 20, p. 136.

---

*It is my opinion, that Dr. Eights has specimens of two distinct species of this genus, which he collected in the Southern Ocean. He will soon publish figures of them, for the examination of entymologists.

B. isoteka, head and tail nearly of the same form and size, and contractile; joints of the abdomen 8; undulations of the joints strong; and the joints curved forward beyond the undulations. Found in transition limerock at Trenton Falls. Published under Isotelus gigas by De Kay, with a suggestion that these two species might form the type of a new genus. But the platycephalus had not then been examined, excepting the head and 8 joints of the abdomen.

B. carcinodea,* mihi, the anterior and posterior parts incurved or folded upon each other, with their terminations meeting evenly: living specimens exhibit a subspherical form when incurved: but the posterior folded half only appears in fossil specimens, which consists of three articulations, a terminal rounded division, and narrow cuniform side-lobes; the articulations of the middle lobe are oblique from the middle backwards, and each side-lobe has but one articulation, which is at its broad or folding end.

When the covering is present it is white carbonate of lime. Found at Cold Spring, on the Mohawk. About three fourths of an inch across. Called Cancer triloboidus in Am. Jour. Sci. v. p. 137.

GENUS NUTTAINIA.† Mihi. (filletted trilobite) Head in three lobes, the middle one most prominent; the two lateral lobes, sub-hemispherical or sub-quadrantal: the whole head bordered anteriorly with a punctured fillet; body distinctly three lobed, middle lobe sub-cylindric, and not so broad as the side lobes.

---

* *Karkinodes*, Greek, of *Karkinos*, crab, *oides*, appearance. I sent specimens to Brongniart, and he told the bearer, that they appeared to be the connecting link between the Trilobite and Crab. Dr. Eights has several specimens of living species resembling this, which he collected on the beach at Cape Horn. They are about 1½ inch long and half as broad, sub cylindric, incurved when at rest. A drawing will soon be published, and a specimen will be sent to Brongniart. The fossil here described and Dr. E's living species seem to me to connect the extinct and living animals of this curious family.

† *Nutto* (or *nusso*) Greek, to puncture—*tainia*, a fillet. I prepared this article and sent it to the printer, under the generic name of Wahlenberg (Entomostracites) with some modification. Afterwards my

N. concentrica, mihi; fillet in the form of a semi-ellipse cut in the direction of its transverse diameter, and truncated so as to present the two ends of the fillet in the line of the same diameter; punctures of the fillet in about 4 or 5 concentric arcs, separated by alternating arcs of fine elevated ridges: middle lobe of the head narrower than the side lobes, more prominent, and tapering posteriorly: whole animal short-ovate: side lobes wing-like, flat, with very narrow joints. The head is found in great numbers in the transition lime-rock of Glenn's Falls, and in the wacke variety of transition argilite on the Champlain Canal, between Waterford and the Mohawk. Three figures, 7 A. B. C. Plate IV, of Brongniart, found in Russia by Stokes, are the heads of this species; but Stokes did not find the bodies. Fig. 6 of the same, is probably a species of this genus. The head excludes all these species from the genus Asaphus.

N. sparsa, mihi; fillet nearly straight in front of the middle lobe of the head; punctures of the fillet scattered irregularly, without any alternating ridges: head compressed, covered with scattered punctures, having its side lobes much smaller than the middle one; middle lobe with straitish sides, giving it somewhat the form of a parallelogram. Found in 3d graywacke, or grit-slate, in Coeymans, 16 miles south-west of Albany. I have the head of one before me, two and a half inches broad and one and a half long. The whole of the animal must have been six or seven inches in length.

pupil, R. F. Livingston, discovered the entire body in two fair specimens; by which it appeared, that W.'s name signifying prickly insect, could not be retained, as the generic name. He had seen the body of two species, *punctatus* and *granulatus*; both of which had prickly or pimpled bodies.

3. RADAIATA, OR ZOOPHYTES (Animal plants.)

CRINOIDITE FAMILY (wheel-whirls.)

These organic fossils are generally found under half an inch in diameter in short cylindrical fragments; and from the appearance of their annulated articulations, are called petrified wheel-whirls. Authors have called them Entrochites and Encrinites. J. Miller, a distinguished naturalist, has been successful in tracing these common branches to central bodies; and drawn characters from them by which he has established nine ~~seven~~ genera and twenty-two species. But it is impossible for students in geology who study rocks in place to determine either genus or species in one case of a hundred, by the aid of Miller's descriptions; because the central body cannot be found by them. I shall therefore continue the use of the names and descriptions, which I published in the 2d vol. Am. Jour. Sci., and which I adopted twelve years since in my school. As I shall describe none but those which I have seen in place and have now before me, the student cannot be misled by me; for when he finds a specimen answering to my description, it will serve as an index to the name under which I have described the rock in which he finds it. As fast as Miller's names can be ascertained, they may be published, and these descriptions be retained.*

---

* Cuvier's concise definitions of Miller's genera are here subjoined, for the purpose of giving the student a general view of the structure of these zoophytes.

The fossils called Entrochites or Encrinites are stems and branches articulated to a central body. The structure of the body naturally divides the genera into three sections.

Section 1. Bodies formed of pieces articulated with the stems, and bearing the rays by similar articulations.

GENUS APOCRINITUS. Stem round and inflated above.

G. ENCRINITUS. Stem round and not inflated.

G. PENTACRINITUS. Stem pentagonal.

Section 2. Bodies formed of angular plates, united at the edges, and in several ranges.

G. PLATYCRINITUS. Having 2 ranges, one of 3 plates and the other of 5.

G. POTERIOCRINITUS. Having 3 ranges, each of 5 plates.

Encrinus or Entrochus.* The stems (being the only parts usually found) are cylindrical columns of articulations resembling pieces of coin piled upon each other like the Voltaic pile; each joint or piece is striated with radii from the centre to the periphery, and has a hole through its centre, forming an axis to the whole column, either filled or empty.

E. transversus (birdseye pins) rings low or confluent, so that the column appears nearly or quite smooth; perforates strata transversely. Found in the lowest and most compact layer of metalliferous limerock. It is called Encrynal by Conybeare, and Birdseye marble by stone-cutters.

E. tricyclus (double jointed whirls) having three kinds of rings, the smallest alternating with each of the other kinds in regular succession. Inner castings are often found; the smallest will then appear most prominent. Found in third graywacke above the coal in Pennsylvania. My best specimens were found in Owego, lying in the direction of the layers of the rock.

E. multiradiatus (many-rayed whirls) articulations many-rayed (from 40 —— 80) very thin, perforate strata transversely. Found in second graywacke in Niskeuna.

[illegible] –

E. curvatus (curved wheel-whirls) articulations distant, with their edges finely double; column always curved and lying between layers. Found in shell lime rock at Glenn's Falls.

G. Cyathocrinitus. Having three ranges, each of 5 plates, the last with inserted plates often increasing it to ten.

G. Actinocrinitus. Having several ranges—1st, of 3 plates, 2d, of 5, others more, and the two first have radiating ridges.

G. Rhodocrinitus. Having several ranges—1st, of 3 plates, 2d, of 5, 3d, of 10; others of more; and the three first have radiating ridges.

Section 3. Bodies formed of a single piece.

G. Eugeniacrinitus. Having the appearance of 5 pieces soldered together.

---

* *Encrinus*, in the form of a lily, called stone-lily. *Entrochus*, in the form of the wheel in a pulley, a circular piece of board as the head of a cask. The stems of this petrifaction are piles of pieces like piles of copper coin; and the body is somewhat lily-like—hence the two names.

E. interruptus, having two kinds of rings, mostly in regular alternations with each other; or rather the high prominent whirls are interrupted by low small ones, single or in pairs. Found in the Coral rag over Coral Cave on the Helderberg; mostly in the direction of the layers of the rock.

E. teretiformis, tapering rapidly; whirls low, even, generally pale or whitish. Found with the last.

E. giganteus (red coralline) branching, red or grey: often compressed, whirls uniform and generally obscure: branches of great length; mostly lying in the direction of the layers, or nearly so. Found in saliferous rocks at Oak Orchard, Mineral Hill in Blenheim, and a mile south of Mt. House.

PENTACRINUS. Stem 5-cornered; rays in 5 lobes.

P. fimbriatus, (fringed whirl,(the 5 lobes fringed with striæ; whorls as of the species Encrinus tricyclus. Found in [illegible] graywacke at Niskeuna with the Encrinus multiradiatus, both perforating the layers of their respective rocks, and also lying in the direction of them sometimes.

ECHINUS. Spheroidal, shelly, and beset with spines; mouth in the middle of the under surface; and having ten bands arranged like meridian lines, each extending from the mouth to the opposite centre.

E. gyracanthus,* mihi; (ring-spine urchin.) Shell in undulating concentric lamellar circles; spines numerous, regularly terete, surrounded by numerous prominent whirls or rings (10 to 15) and terminating in naked points. The spines are often found in the cleavages of the Corniferous limerock of Bethlehem, pointing in all directions, without the presence of the body. I counted 200 spines on a surface of three square inches, averaging one third of an inch in length, and the sixteenth of an inch in diameter at the large end.

CYATHOPHYLLUM.† [Goldfuss] stem calcareous, free or rooting: lamellæ from cup-form cells, proliferous from the centre or margin accumulated into a cylinder; cylinders turbinate, mostly horn-form, solitary or united in groups, transversely rugose and longitudinally striate; terminal cell at the largest end generally radiately plaited-lamellar.

---

* *Guros*, a whirl or ring, *akanthos*, thorn.

† *Kuathos*, a cup, *phullon*, a leaf or lamina. Acervularia, Madrepora, Caryophyllea, of authors.

C. ceratites (common stone-horn) free, single, cone-form and incurved towards the apex; cell of the base cup-form with erect margin, having from 40 to 60 subdentate and sub-equal laminæ.

C. flexuosum (zigzag horn) flexuose, sub-cylindric; base cell sub-funnel-form, with slender equal laminæ.

C. vermiculare (ridgy horn) sub-cylindrical, with large transverse rugæ or geniculate ridges, sometimes flexuose or irregularly curved, so as to give the joints the appearance of being irregularly united; lamellæ few, remote, equal.

C. vesiculosum (porous horn) turbinate; base cell sub-funnel-form; lamellæ formed into cells. The cells are oval, spherical, concavo-convex, and irregular.

C. quadrigeminum (pin horn) cespitose with numerous minute sub-cylindrical columns coalescing in a sub-spherical mass; proliferous, three or four from one base; disk of each flattish, often rising a little in the middle, lamellæ very narrow, greater and smaller ones alternating. In my specimens, each column is about the sixteenth of an inch in diameter, and from two to four hundred are united in each spherical mass. Their disks present a beautifully radiated appearance under a lens.

C. hexagonum (wry-neck horns) rugose, sub-cylindrical, hexagonal, or pentagonal, with the disk reflexed; segregate (single,) or cespitose and proliferous. My specimen is single, three-fourths of an inch in diameter, cylindrical, and reflexed at right angles so as to bring the disk into a vertical position.

C. helianthoides (sunflower horns) cespitose or solitary; when cespitose each column is pentagonal or hexagonal; when solitary it is elongated and proliferous, or short-turbinate: the disk has from 60 to 80 rays in pairs confluent, with the margin more or less reflexed. I found the cespitose and turbinate varieties.

N. B. The seven species described above, we found at Bethlehem and Van Schaak's. They are all confined to the Corniferous Limerock.

G. hypocrateriformis (salver horns) turbinate and sub-cylindric, single or cespitose: the terminal disk tubular in the centre and the limb flat; the equal rays come to the bottom by pairs. My specimen is single; I found it on the south shore of Lake Erie.

TURBINOLA.* [Lamarck] turbinate, simple, free, solitary, not rugose or with smooth rugæ, cells lamellose; lamellæ (connected at the centre and naked at the sides) form one terminal cell at the disk.

T. mitrata (mitred cone, smooth horn) sub-compressed on the sides; apex incurved: lamellæ thickish, cub-connate and papillose at the surface, unequal, somewhat toothed, forming an ovate, stellate disk. My specimens average an inch in length. Found at Glenn's Falls.

MADREPORITE FAMILY.

MADREPORA. (tree corals) Cells obliquely radiating, constituting a calcareous stipe, confert, and depressed in the centre.

M. limbata (branching coral) branching and the branches sub-cylindrical; the mouths of the cells radiate-straite in the periphery. I found one specimen on the south shore of Lake Erie, near 18 mile Creek.†

LITHODENDRON.‡ Sch. (stone trees) Stem calcareous, affixed, tree-form; lamellar cells combined in a branching trunk: the trunk cylindrical or thickened at the base; branches terete; terminal cells cup-form.

L. dichotomum (cylindrical stone tree) Cespitose, erect. Sub-flexuose; branches dichotomous, densely striate; little stars excavated orbicularly. Very common at Glenn's Falls, lying between the layers of the limerock.

---

* Hippurites of authors.

† Goldfuss says, there is in North America near Chesapeak Bay, *M. palmata* (hand coral) compressed, palmate, cells remote, immersed; lamellæ conjoined in net-like form in the centre, with glabrous interstices. Students should search for this species, as more species of this genus would be useful in determining some of our strata.

‡ Madrepora Lin. Caryophyllea, Lam.

L. plicatum (flattened stone tree) Branching, cespitose; branches compressed, erect, densely striate, fastigiate, bifid or trifid: the little stars irregularly plicate. Found at Glenn's Falls, generally perforating the layers of limestone, like the Encrinus transversus; but is readily distinguished by its compressed stems.

Astrea. (star corals) Stems calcareous, irregular, incrusted or glomerate; lamellæ from the tubes parallel or radiating, either contiguous or conjoined by interposed porous masses: the terminal cells form stellate laminæ.

A. stylapora (star-stone) Hemispherical; little stars angle-tubular, approximating and contiguous, margin glabrous, lamellae distant; the centre of the column or star extended a little. Common in the south bank of Lake Erie; about one inch in diameter.

A. porosa (great star-stone) Fungi-form, (sub-spherical) or sub-ramous: little stars equal, remote, excavated; lamellae rather distant with pores irregularly interposed. I found a specimen on the south shore of Lake Erie, about two inches in diameter, and covered with a half inch coat of iron pyrites.

TUBIPORITE FAMILY.

Columnaria. Stem calcareous; tubes prismatic, contiguous, parallel or radiating; partitions transverse without any communicating pores: tubes lamellar within and the laminæ radiate.

C. alveolata (coral cakes) Hemispherical (often concave-convex, and sometimes flat) tubes unequal in length, striated longitudinally, and radiating from the base; these lamellæ of the little stars are rather remote which radiate from the centre, the marginal ones alternating. Very abundant over the Coral cave, on the Helderburg. They are from three inches in diameter to ten.

C. sulcata (furrowed corals) tubes generally parallel and straight, sometimes a little curved; furrowed longitudinally and sub-striate: lamellæ of the stars radiating from the center, and the marginal ones alternating. Very abundant in transition limerock, at Glenn's Falls, where it is generally dark brown. We find some there whose prismatic columns are six inches long.

C. intermedia, mihi: tubes sub-striate, scarcely sulcate; mostly parallel when in large formless masses and radiating when in small obconic masses. It seems to be intermediate in character, (as it is in stratiographical position) between the *alveolata* and *sulcata*. It is distinguished from *sarcinula micropthalma* by its prismatic tubes. Found near Bethlehem caverns in cherty limerock. Not described in Goldfuss.

Sarcinula. Stems calcareous, conglomerated: tubes cylindrical (sometimes angular by compression) diverging, sometimes almost parallel; intermediate laminæ transverse and joined in fascicles: transverse partitions within the tubes, and laminæ radiating in whorls.

S. micropthalma, tubes diverging, remotely ribbed; rays of each tube 6, in whorls, and each ray twice forked; lamellæ connected remotely. Bethlehem and Van Schaack's.

S. ramosa, mihi; tubes distant and branching irregularly but not frequently. It resembles the *micropthalma*; but cannot be considered as a variety, on account of the irregular courses the tubes pursue through the mass of rock, and the branching into almost equal parts which sometimes occurs. Found at Bethlehem caverns.

Syringopora. Calcareous; tubes cylindrical, parallel, or diverging, remote; the diaphragm-like partitions across the tube, originating from central proliferous funnel form organs, are conjoined among each other in lateral single tubes.

S. verticellata, tubes straight, remote, lateral tubes connected, sometimes whorled. Goldfuss says, this is found near Lake Huron. I have not seen it in place.

Catenipora. Calcareous; tubes parallel, constituting vertical laminæ in net-like chains: tubes compressed, intercepted within with transverse partitions.

C. escharoides (chain coral) tubiferous, laminæ anastamosing net-like, and the meshes (alveoles) irregular, sub-pentagonal; the little mouths of the tubes (or links) lanceolate. Found in Caledonia, N. Y.

FUNGITE FAMILY.

Fungia. Cell solitary, simple, free, disk-form or hemispheric, constructed of entire or denticulated subperpendicular laminæ, coalescent below, and forming in the upper surface one star. The star occupying the whole upper surface, has its centre impressed. The lower superficies is somewhat flattish, sulcate-striate in a radiated or concentrated manner.

F. polymorpha, (many-faced fungite) convex or hemispherical above, with an oblong depression in the middle (often obscure); lamellæ equal, confert, granulated; at the base concentrically sulcate, with minute radiating striae. Several varieties of this species are common at Glenn's Falls and Amsterdam: where they often lie with their convex sides projecting from the rock's surface.

F. discoidea (flat-faced fungite) convex both sides, but presents a flattened disk above and depression in the orbicular centre beneath: lamellæ confert, equal, thickish, toothed, cross-barred; rugose furrows concentric at the base. Very common at Glenn's Falls, where they are generally immersed in the rock, so that the upper surface is nearly level with the surface of the rock.

Alcyonia. Funnel-form or pileus-like, supported on a stipe: tubes, arising from within the stipe, radiate to the disk or brim of the pileus.

A. fungioidea, mihi; (fungus stone) pileus flat, with the tubes mostly radiating to, and terminating in, the broad vertical brim. Our specimen was found in a cavern at Bethlehem. It is now in the Troy Lyceum, labelled Alcyonia in the hand-writing of Le Sueur—I remember shewing it to him at Albany in 1819. See Conybeare and Philips, p. 76.

GORGONITE FAMILY.

Gorgonia. (Petal stones) stem affixed, sub-dendritic; its axis corneous and distinct; crust permanent, fibrous, calcareous.

G. ripisteria, very branching and net-form, spread out like a fan; branchlets sub-compressed, coalescent, minutely striated: bark granulose. Found at Bethlehem in corniferous limerock 1 ½ inches long.

G. infundibiliformis, undulated-funnel-form, (or appearing like a petal or spread fan) most finely reticulated; meshes appear like pin-holes, a little oval and approaching the quincunx order. Found over Coral Cave. About an inch in length.

Diploctenium. (Double-comb) Consists of stony polypi arranged so as to resemble a fan-form leaf: laminae in pairs, connate below; both superficies are lamellar and radiating from the base.

D. pluma (feather comb) oblong, sub-flexuose; inner lamellae straight and in pairs, outer ones minutely undulated. Found over Coral Cave. About an inch in length.

RETEPORITE FAMILY.

Retepora. (Net stones) reticulate-branched, or punctured, net-like; cells stony; mouths of the cells unilateral.

R. disticha (two-sided net-coral) ramose, branches sub-dichotomous; lateral pores alternate, obliquely or transversely in 2 sided rows, tubular. The specimens before me are in the same rock with the *Catenipora escharoides*, from Caledonia. They are obscure and doubtful. I introduce this genus, because I believe I recollect seeing specimens of this genus in our district; but I have no good one present.

Coscinopora. Polypi cup-form, fibrous, punctured quincunx funnel-form pores; fibres densely compressed.

C. macropora (large-mouthed net-stone) patella-form, pores orbicular, interstices with greater or less punctures.

In second graywacke on Becraft Mt. near Hudson. Very irregular in external form.

C. infundibiliformis (funnel net-stone) funnel-form, perforated at the bottom; little-mouths arranged in the direction of numerous arcs of circles crossing each other obliquely, by having their centers considerably distant. I have a beautiful specimen two and a half inches by three and a half, from the graywacke with the *C. macropora*.

C. sulcata (checkered net-stone) ventricose, apertures of pores within rhomboidal, wihout orbicular; furrows immersed longitudinally. My specimens are from Bethlehem caverns. They are very perfectly checked; but the checks often meet at angles. The furrows are deep one way, with shallow lines the other way; like furrowing out rows of corn deeply one way and with a shallow furrow the other way.

FLUSTRA. Stem fixed, consisting of numerous cells, united somewhat like those of honeycomb: sometimes it is a mere mat of cells incrusted on the surface of another body.

F. carbaseoides, mihi; stem subdivided or branched; cells in tesselated rhombs. Resembles the recent *Flustra carbasaa*. Abundant at Glenns' Falls. Found by Prof. Fowler recently in transition limerock on the east shore of Lake Champlain, Vermont. A species of this genus is found in the transition silicious slate on the bank of Hudson river in the city of Hudson; but my specimens are not sufficient to enable me to detect specific character; but I believe it is this.

Students should be told, that the cheeked appearance of most species of the flustra is made by the termination of oblique tubes. Therefore they may often determine the genus by the exposed sides of these tubes lying upon each other in imbricated order, like grains of wheat in the head, when the cheekered order of their termination is not manifest.

Remarks. It may appear to be a great absurdity, that I have described no bivalve molusci, to those who have never made an application of organized remains for the purpose of determining geological strata. The following are my reasons.

1. They are the most difficult to determine of all remains. First, because they are most numerous for their cemented fragments often constitute almost the entire mass of a limerock. As different species approach each other in so many points of character, they can scarcely be distinguished in the most perfect specimens —or even in the recent state. Second, because the hinges, cardinal and lateral teeth, are essential for determining most species. These are either obliterated, on account of their perishable nature, or are hidden in the interior of a closed shell. We are, therefore, compelled to resort to the general configuration, as figured by Sowerby and others; which is a very indefinite method on account of the near approach in configuration, even between different genera.

2. The remains of animals of the genus Orthocera, Ammonites, and Bellerophon, of the numerous species of articulated and radiated animals, are to be found in all strata, where bivalves are found; and they can be determined by any small fragment of any part.

It is proper to add, that a few species of bivalves may be found useful, or even necessary. Students in geology are requested to consider the PRODUCTUS *depressus*, TEREBRATULA *ovoides*, *perovalis*, *spiriferoides*.

PRODUCTUS *depressus* has a straight hinge, so as to resemble the form of the letter D., and sometimes approaches a square form. It is flat on the upper side, and its whole surface is in undulated wrinkles. It is found in corniferous limerock (the upper terminating formation of the lower secondary series) and in the 2d graywacke, which forms the lower formation of the same series. It is therefore important in illustrating the cotemporaneous character of the series.

TEREBRATULA, *ovoides* and *perovalis*. The *ovoides* is nearly egg-form, the *perovalis* is a long oval. They are both found with the Bellerophon in the calcareous grit, or shell grit, on the Helderberg—also in all parts of Europe in the same rock.

TEREBRATULA *spiriferoides*. This is very common in the grit slate, in 3d graywacke slate, on the south shore of Lake Erie. It may serve as an index to determine equivalents in this country. I will therefore describe it.

T. spiriferoides, mihi, Broader than long; transversely sulcated, or rather having concentric imbricated layers; not striated longitudinally: beak somewhat incurved, the most prominent perforated, and the perforation remarkably well preserved in most specimens: hinge straightish, and presenting the appearance of a *spirifer*. From an inch to an inch and a half long. Very perfect along the south shore of Lake Erie from 16 to 24 miles west of Buffalo—particularly on each side of the mouth of Eighteen-mile Creek.

I am aware of the importance of other organized remains, as conducing to the object proposed. But I have not been able to ascertain the precise strata, in which other relics, known to me, are found in this country. Authors, who have described them, are probably correct; but we might not agree in the naming—and I even doubt in some cases, which I have here set down as fixed. Dr. Bigsby's splendid ogyges boltoni is unquestionably correct; but I have not been able to settle its precise associations. The upper rock at Lockport I call, Geodiferous limerock—the rock under it, is a slaty variety of the liasoid rock, or hydraulic cement. Numerous other ascertained relics are similarly situated; particularly several species of Orthocera and Ammonites.

These 22 pages are published for the purpose of promoting enquiry. Students will be induced to begin to make collections; and matured geologists will be prepared to answer the question—how many, and which, species of relics will be sufficient for ascertaining all our strata?

STRUCTURE OF THE EARTH.

Any theory so constructed as to be in accordance with known facts and appearances, whether susceptible of demonstration or not, aids the memory in the study of Geology. I shall therefore adopt one, but disclaim all responsibility for its support; as future discoveries may prove it to be untenable.

CREATION.

Attempts have been made to shew that the six days labor, recorded by Moses, can now be traced, day by day, in the present appearances of the earth.* For this purpose some take each day for a thousand years; relying on a passage in the Bible that "a thousand years are as one day with the Creator". Others consider a day at the creation as an undefined portion of time, because the sun was not appointed "to rule the day" until three of the days had past. Others say, that the Creator hastened the ordinary operations of nature, so that the same events were brought about in twenty-four hours, that ordinarily occur since that period, in a thousand years. Thus by giving an increased velocity to chemical and philosophical attraction in the ratio of three hundred and sixty-five thousand to one; matter would assume the organized form of animals and vegetables, and pass to the state of death and petrifaction in the three hundred and sixty-five thousandth part of the time now required for the same processes. Others do not consider the Bible as intended for a system of Geology or Astronomy; therefore do not deem the sun's standing still at the command of Joshua any evidence that the earth does not turn on its axis—nor the recent date of the creation as evidence that the organized remains found in transition and secondary rocks ought to be ascribed to a *Lusus Naturæ.* Dr. Scott, the learned annotator on the Bible, says—"the chaotic mass seems to have been instantaneously created out of nothing, and then gradually reduced to order and beauty." We may add, that we have no means of knowing, whether the words, "*In the beginning* God created the heaven and the earth," refer to the *beginning of the six days work* of creation, or to a period many thousands of years before that event.

---

* The remarkable coincidences between the Mosaic account of the order in which organized beings were created, and the order of superposition now held by organized remains, often attract the attention of the curious student in geology. According to the Mosaic account, gramineous plants were created on the third day—aquatic animals on the fifth day—dry land animals, on the sixth day; and man was the last of the dry land animals. Now we find petrifactions of gramineous plants in the oldest formation of every series, together with ferns and palm-like plants—petrifactions of aquatic animals in the more recent formations—but no relics of dry land animals are found below the uppermost (most recent) of all the series of deposites. But the remains of man has not been found in antediluvial strata; which seems to accord with his having been created after the surface of the earth was settled, and all other works of creation were finished.

REGULAR DEPOSITES.

SUCCESSIONS OF MODIFICATIONS OF THE SURFACE OF THE EARTH, AND OF THE EXTINCTION AND RE-CREATION OF ANIMALS.

The geological deposites of this country (and probably those of the eastern continent,) exhibit grounds for conjecture, if not absolute demonstration, that the surface of the earth has undergone five general modifications, which no animals survived. Four of these modifications were followed by as many new creations of animals. Also that two new creations of animals succeeded the final depositions of all regular strata. In the whole, there appears to have been five creations of animals, at least (perhaps ten) since the primitive mass of the earth was formed; and a long interval succeeded each creation.

I shall here make references to localities in proof of this statement; but a more full account of them in particular localities will appear in the alphabetical arrangement of geographical localities. I will premise, that we have five series of strata, or a five-fold repetition of a Carboniferous, Quartzose, and Calcareous formation. The first is called primitive, and contains no organized remains. In each of the other four series, the carboniferous, and calcareous formations, contain organized remains; but the quartzose formations are destitute of such relics.*

Each of the five series of (carboniferous, quartzose, and calcareous,) strata, is terminated by a stratum containing a large proportion of carbonate of lime. The characteristics of these terminal strata are the following

CLASSES OF REGULAR DEPOSITS.

First Series (primitive) is terminated by *granular limerock*, destitute of any organized remains. Ex. From Connecticut River to New York line.

Second Series (transition) is terminated by *compact* and *shelly limerocks;* the compact perforated with encrinites, (called *encrinal* limerock by Conybeare,) the shelly containing fungia (may be called *fungital* limerock.) In this series radiated and molluscous relics are found; but the latter have more than one valve, or are one-valved and chambered. Ex. From Massachusetts line to the foot of Helderberg Mountains.

Third Series (lower secondary) is terminated by *corniferous* or *cherty limerock;* it contains horn-stone, and abounds in stone horns, called Cyathophyllites, (may be called *ceratial*† limerock). Univalves, *not chambered,* first appear in this series. Ex. From Trenton Falls to Otsego limerock.

Fourth Series (upper secondary) is terminated by limerock; as *chalk, oolite,* or *coral rag.* It always has, near or at its termination, a calcareous stratum containing hemispherical and fan-form corals, (may be called *coral* limerock.) Vertebrated oviparous animals are found in it in some localities on the Eastern continent, in lias rock. Ex. From Bethlehem caverns to Coral Cave north of Pucker street on the Helderberg.

Fifth Series (tertiary) is terminated by a lime deposite of shell marl; which abounds in, (or rather consists of) molluscous relics of the *helicite* (snail) family (may be called *helicital* marl). This series has its strata, mostly, not indurated, and embraces numerous vertebral animals, some of which are viviparous. Ex. Middletown and South Amboy, New Jersey—also Erie Canal west of Nine-mile Creek.

---

* It may hereafter be proved, that a new creation of animals preceded and succeeded the quartzose deposites in each series. This would make ten creations of animals.

† From *keration* Gr. a little horn.

Recapitulation. *First Series* (primitive) terminated by Granular limerock. *Second Series* (transition) terminated by Fungital limerock. *Third Series* (lower secondary) terminated by Ceratial limerock. *Fourth Series* (upper secondary) terminated by Coral limerock. *Fifth Series* (tertiary) terminated by Helicital marl.

We learn from inspecting the geological strata of North America, that vegetables were planted upon the carbonate of lime termination of each series, or class of strata. Because vegetables, in a charred and uncharred state, are found in the next succeeding stratum, which is always slaty. Aquatic animals, mostly marine, succeeded the vegetables, until the fourth series was completed. Then a few dry land vertebrated oviparous and viviparous animals were created; whose remains are found in the tertiary class. Timber trees were planted and grew at the same time; whose charred remains we now find in the marly clay of Jersey tertiary, along the south bank of Amboy bay, and in other places.

Man appears to have been made after the deposition of the tertiary series; for his remains are never found in it, nor in any of the preceding series. An aqueous deluge swept most of his species, and of his associate animals, from the earth. The diluvial deposites have preserved many records of antideluvial existence. Pachydermous (thick skin) animals, as elephants; a few ruminantia (cud-chawers) as deer; carnaria (flesh-eaters) as hyenas, have left their preserved remains. But we have numerous animals at this day whose remains are not found in diluvion; and would be as likely to be preserved, as those which are most common. Hence we may justly infer, that an extensive creation of animals has occurred since the deluge. The same inference in respect to plants is still better supported; because plants are more easily preserved than animals, as they are less perishable.

Disturbances of regular deposites.

After the first series of strata had been deposited, (according to Werner in concentric spheres, like the coats of an onion,) it appears that these strata were broken up, or burst through in several northerly and southerly rents, by an inconceivable force, exerted beneath the stratum of granite. The most important of those rents are represented in Fig. 2, of the wood-cuts in this text-book. This effort of Nature (generally ascribed to the production and expansion of steam by internal heat) raised the broken edges of the granite to such a height, that they are rarely covered by later deposites. As they are universal, they form excellent starting points. Hence Werner commenced with granite as the first in his series; and all further discoveries confirm the correctness of his views in this particular.*

---

*Conybeare, having collected materials for the upper deposites before he had investigated the lower ones, began with the uppermost, in his treatise. The confusion which such a method would induce, beginning with strata, rarely to be found (the white chalk has not yet been found in America,) it is hoped will prevent its introduction.

EXPLANATIONS OF THE WOOD-CUTS.

The first figure is supposed to represent the concentric hollow spheres, constituting the exterior rind of the earth; one overlaying another, like the coats of an onion. We may imagine that these concentric hollow spheres continue to the center of the earth—(or, like Cordier, we may imagine the interior now in a state of fusion.) We can inspect all the strata, in regular order of superposition, which are represented in this figure; but we know nothing of the dark-coloured interior, excepting, that it exceeds the exterior in specific gravity. This was first shewn by Dr. Maskelyne, and is now universally received.*

In the second figure, the combustible materials of the first figure (1, 2, 3, 4, 5, 6;) are supposed to have been ignited; and by the expansion of steam or otherwise, to have produced those rents in the earth, represented by the same series of figures. This would raise the edges of primitive rocks higher than those, which rest upon them; and thus exhibit our present order of series and formations.

In the third figure, the series (or classes) of deposites, excepting the tertiary (detritus) are represented, according to their present positions, in a transverse segment from the Atlantic to the Pacific, across the continent of North America. Stratification is shewn by the number of series, with an abbreviation for each formation. From the Mississippi east to the Atlantic, the general representation of the order of superposition is known to be correct. West of the Mississippi the country has not been thoroughly explored. The vast disproportion between the elevation and longitudinal extension, is sanctioned by usage, and is absolutely necessary. If true proportion was regarded, the height of Rocky Mts. would not be equal to the necessary diameter of a hair-stroke line.

---

* This was demonstrated by suspending a plumb-line by the side of Mt. Shehallon in Scotland, and noting its deviation from perpendicular.

EXHIBITION OF TWO TRANSVERSE SEGMENTS.

The earth is here supposed to be cut into two parts, at the 42° of north latitude.

The observer is supposed to stand south of the center of the segments—all the earth, south of him, being removed.

EXPLANATIONS.

Formations.

Figures 1 and 2.[*] A. Lower carboniferous formation —E. Lower quartzose formation—I. Lower calcareous formation—O. The lower side of the second carboniferous formation when used in Fig. 1. This lower part may be primitive. When used in Fig. 2, it is for all that formation—U. Second quartzose formation—X. Second calcareous formation—W. Oceanic waters.

Combustibles.

These are indicated by numeral figures. In Fig. 1, they are represented as they are supposed to have been deposited at the creation. In Fig. 2, they are represented as having been consumed by combustion, whereby an explosion was produced, which burst through the primitive and transition series—the only deposites then made; and those not perfectly indurated. 1. The combustibles under Rocky Mt.—2. New-England—3. Britain—4. Alps and Pyrennes—5. Caucasus—6. Himmalay.

Remarks. In Fig. 1, the water is represented as encompassing the whole earth; being pressed out to the surface by the greater specific gravity of the earthy materials. While the earth and waters were in the quiescent state, no organized beings, but marine, were provided with a place of residence. In due time the combustible materials marked 1, 2, 3, 4, 5, 6, were ignited, and produced the changes exhibited in Fig. 2.

---

[*] These figures are an improvement upon those published in my Geological Index, in 1820, and afterwards copied into Woodbridge's Geography.

Fig. 1.

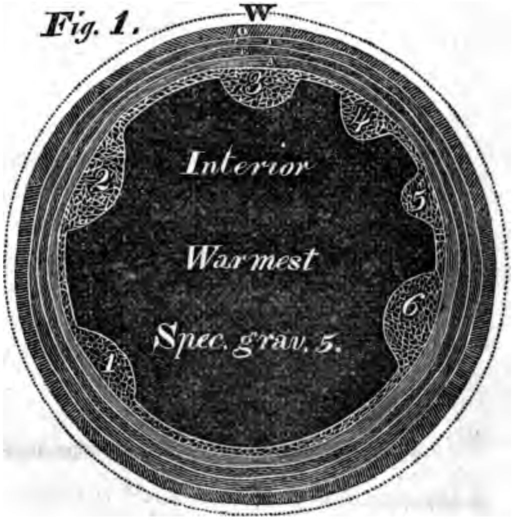
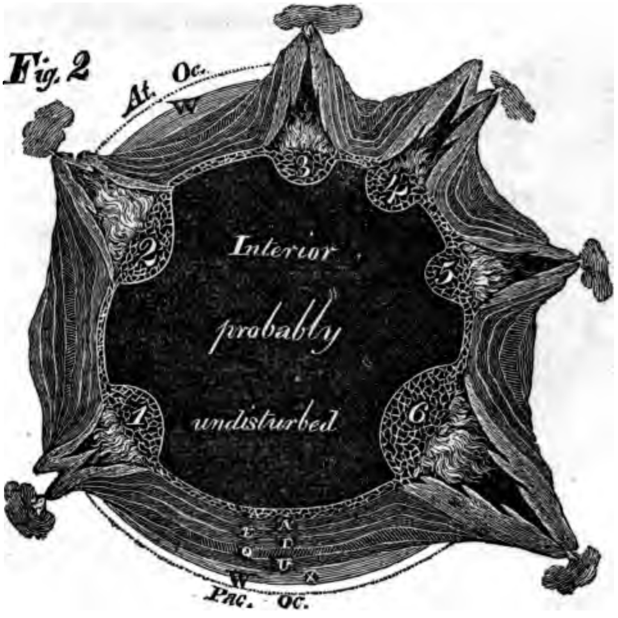

W
O
E
A
3
4
2
5
6
1
Interior
Warmest
Spec. grav. 5.

Fig. 2


At. Oc.
W
3
4
2
5
1
6
Interior
probably
undisturbed
A
E
Q
U
X
W
Pac. Oc.

EXHIBITION OF A TRANSVERSE SEGMENT.

The continent of North America is here supposed to be cut into two parts between 42° and 43° north latitude.

The observer is supposed to stand south of the middle of the segment—that part of the continent which is south of him being removed.

EXPLANATIONS.

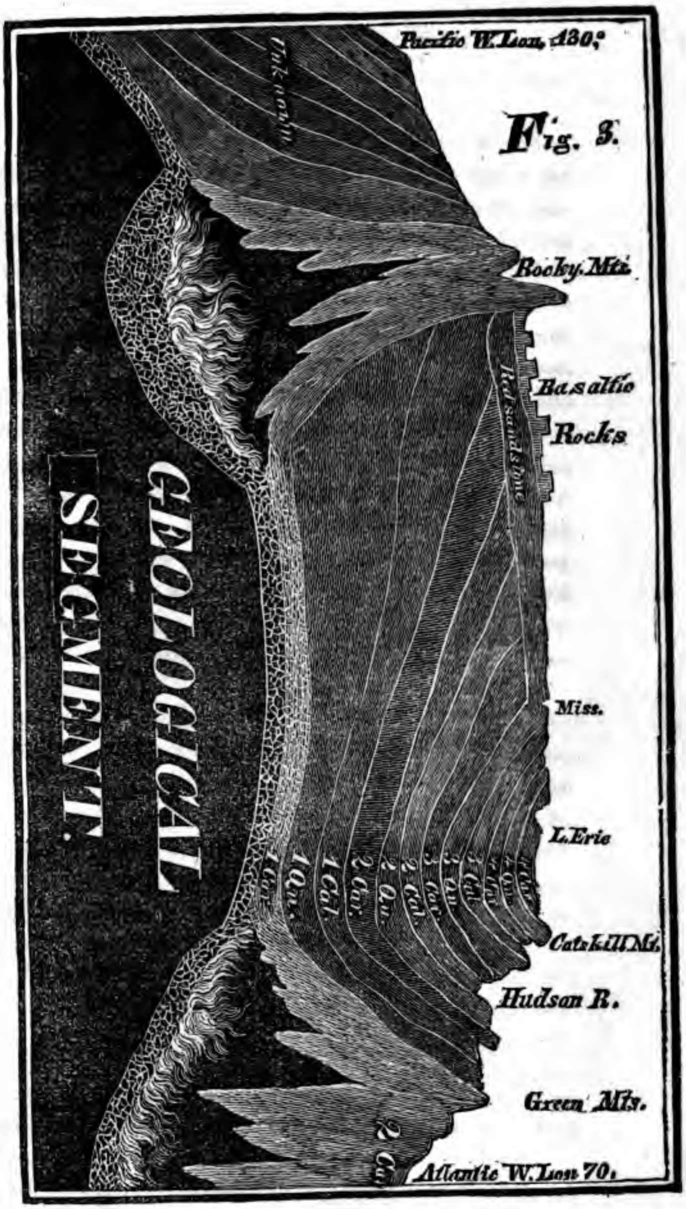
Fig. 3. This figure represents a segment of the earth from the Atlantic to the Pacific, between the 42° and 43° N. latitude, in its present state, so far as regards rock strata. The tertiary formation, or antediluvial detritus, may be supposed to overlay the rock strata in most of the depressed situations. The 3d and 4th series may be supposed to have been mostly deposited after the great explosion, ~~represented on Fi~~ [redacted] ~~and the tertiary, or 5th series,~~ [redacted] last of all the regular se [redacted] above the lower side of the argillite, may be supposed to be made up by the abrasions and disintegrations of the then soft concentric strata, represented in Fig. 1. For, as we may suppose them broken up soon after their deposition, they were in a semi-indurated state, and readily washed from their original situation, by the numerous currents which the uneven surface would then cause.

Abbreviations.

Car. Carboniferous formations—Qu. Quartzose formations—Cal. Calcareous formations. The numerals indicate the first, second, third, fourth and fifth series of formations. The fifth, however, is not represented here. ~~See definition of it, fifth series.~~

Remarks. In Fig. 3, the present state of the earth is represented, after several vast explosions; as, according to Cuvier's theory, "life has often been disturbed on this earth by terrible events." The combustible materials are now supposed to be too nearly exhausted to produce such general explosions; but are still sufficient for ordinary earthquakes.

Fig. 3.


Pacific W. Lon. 130°
Rocky Mts.
Basaltic Rocks
Miss.
L. Erie
Catskill Mt.
Hudson R.
Green Mts.
Atlantic W. Lon. 70.
GEOLOGICAL
SEGMENT.
Unknown
Red sandstone
1 Car.
1 Qu.
1 Cal.
2 Car.
2 Qu.
2 Cal.
3 Car.
3 Qu.
3 Cal.
4 Car.
4 Qu.
2 Car.

Slade

ANOMALOUS DEPOSITS,

Are those which are produced at the earth's surface by the *fusion* or *disintegration* of regular strata.

I. VOLCANIC DEPOSITS. Hornblende basaltic rocks, deposited since the primitive explosion and before the deluge; or more recent deposites of lava, breccia, ashes, stones, &c. produced by the direct action of volcanic heat upon the substance of the regular deposites.

II. DILUVION. Subdivisions. PROPER DILUVION is a confused mixture of gravel, sand, clay, loam, plants, animals, &c. so situated that it must have been deposited from water in a state of violent action, which could not have been produced by any existing cause: or it must agree in character with deposites which are thus situated. Never contains works of art. ULTIMATE DILUVION, a thin deposite of greyish, yellow loam, reposing on other strata, in all ancient uncultivated forests, which have not been cut away since the deluge. It is so situated, that it cannot have been deposited from water while running with much velocity; but it appears to be the last settlings of a deluge.

III. POST DILUVION.* Any detritus deposited by water since the deluge; which is distinguished by the coarser pebbles being nearest to, and the finer sediment remotest from, the source of water which made the deposites. May contain works of art.

IV. ANALLUVION. Any detritus which has not been washed from the place of its first disintegration; it being the pulverized surface of the underlaying rock.

GEOLOGICAL SYNOPSIS;

Exhibiting each stratum by a wood cut figure.

All general strata, are arranged under their respective classes, or series; proceeding from the bottom of each page to the top.

Five classes of regular strata are adopted; for the secondary class is, with great propriety, divided into *upper* and *lower*, by late European geologists. This accords with the distribution of strata into series of *ternary formations*.

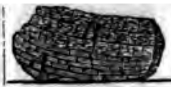
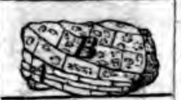
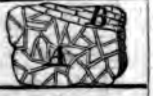
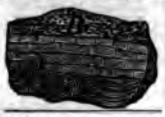
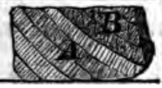
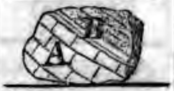
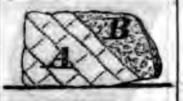
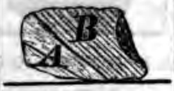
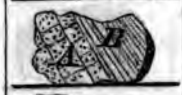
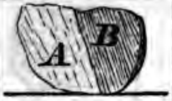
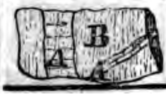
---

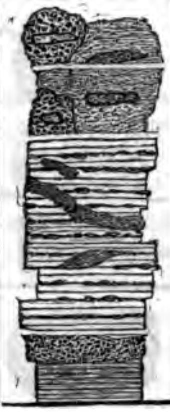
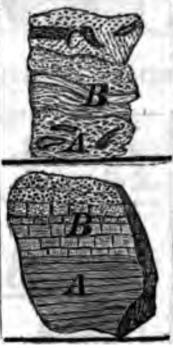
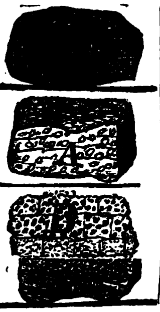
* Very absurdly called *alluvion;* as this is a generic term of long standing.

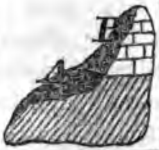
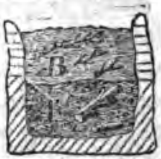
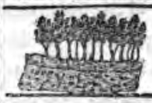
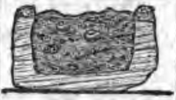
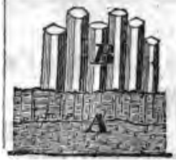
The *wood cut figures* represent the strata of each series or class.

Anomalous deposits are not classified; because the agreement in character, among them, will not authorize any systematic arrangement.

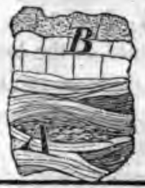
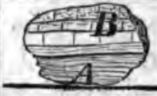
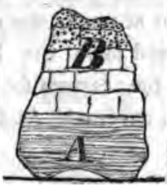
The most important subordinate rocks are separated, in this synopsis, from the regular series. It is remarkable, that the subordinate rocks along the Erie Canal, containing the salt, iron, and gypsum, seem to proceed from the northern primitive rocks, between Lakes Ontario and Champlain (called McCombs Mountains). In this locality of primitive rocks, the mica-slate, talcose slate, granular quartz, and granular limerock, are wanting. All of which are present in the Green Mt. range. The argillite and first graywacke (including transition red sand-stone) are wanting between the primitive and lower secondary. And these are all present in the series of rocks, proceeding from the Green Mountain range from Pittsfield Mass. to Pittsburgh in Pennsylvania, or to the state of Ohio, along the south line of the state of New York.

SERIES, FORMATIONS AND GENERAL STRATA.	STRUCTURES REPRESENTED.	SUB-DIVISIONS OF STRATA AND COMMON NAMES.
II. SERIES. TRANSITION.		
3. *Calcarious formation.* Metalliferous lime-rock.		B. Fungital, Shelly. A. Encrinal, Birdseye marble.
Calciferous sandrock.		B. Geodal calc sandrock. A. Slaty calc sandrock.
Sparry limerock.		B. Veiny limerock. A. Tesselated limerock.
2. *Quartzose formation.* First graywacke.		B. Millstone grit, rubble, old red-sandstone. A. Grit-slate horizontal.
1. *Carboniferous formation.* Argillite.		B. Wacke-slate inclined. A. Clay-slate inclined.
I. SERIES. PRIMITIVE.		
3. *Calcarious formation.* Granular limerock.		B. Sandy marble. A. Statuary marble.
2. *Quartzose formation.* Granular quartz.		B. Sandy quartz. A. Compact quartz.
1. *Carboniferous formation.* Talcose rock.		B. Fissile, Chloritic. A. Steatite, Soapstone.
Hornblende rock.		B. Slaty, Gneissoid. A. Granitic, Sienite, Porphyry.
Mica-slate.		B. Fissile. A. Compact.
Granite.		B. Slaty, Gneiss, Porphyritic. A. Crystalline, Graphic.

SERIES, FORMATIONS AND GENERAL STRATA.	STRUCTURE.	SUBDIVISIONS OF STRATA AND COMMON NAMES.
V. SERIES. TERTIARY.		
3. *Calcarious formation.* Shell marl. 2. *Quartzose formation.* Marine sand and crag. 1. *Carboniferous formation.* Marly clay. Plastic clay.		Pulverized. Stratified, tufaceous, helicitic. Stratified sand. Stratified gravel, hardpan Adhesive clay. Clay marl. Blue clay. Refractory clay. Pipe Clay.
IV. SERIES. UPPER SECONDARY.		
3. *Calcarious formation.* Oolitic rocks. 2. *Quartzose formation.* Third graywacke. 1. *Carboniferous formation.*		C. Chlorite chalk, green-sand. B. Upper oolite. A. Coral rag, shell-grit. B. Millstone grit, rubble, red sandrock. A. Grit-slate, hone-slate, red-wacke.
III. SERIES. LOWER SECONDARY.		
3. *Calcarious formation.* Corniferous rock, or ceratial. Geodiferous limerock. 2. *Quartzose formation.* Second graywacke. 1. *Carboniferous formation.*		B. Cherty limerock. A. Stratified hornrock. B. Stratified and sandy. A. Irregular limestone. B. Milstone grit, rubble, red-sandstone. A. Grit-slate, hone-slate, conc hdal slate.

ANOMALOUS DEPOSITES.	STRUCTURE.	SUBDIVISIONS AND COMMON NAMES.
ANALLUVION.		B. Granulated soil. A. Argillaceous soil.
POST DILUVION.		B. Fine sediment. A. Pebbles or gravel.
ULTIMATE DILUVION.		Yellowish grey, sandy. Greyish yellow, loamy.
PROPER DILUVION.		Sand and loam. Gravel. Vegetable mould.
VOLCANIC ROCKS.		B. Basaltic columns. A. Amygdaloid, Breccia, Lava, Trachite.

SUBORDINATE TO SERIES III.

3. *Calcareous.*		B. Sandy and slaty lias, or liasoid. A. Slaty and wacke-like lias, or liasoid.
2. *Quartzose and slaty.*		B. Sandy ferriferous rock. A. Slaty ferriferous rock.
1. *Carboniferous and quartzose.*		B. Saliferous sand-rock and conglomerate. A. Saliferous marl-slate.

Remark, 1. I have removed the strata, which afford the salt, iron, gypsum, and hydraulic cement, from the regular series, and treated them as subordinates, with a view to relieve the student from embarrassment. Commencing near Utica they extend a great distance along the Erie Canal; but Lake Ontario is their northern limit, and they terminate in a cunei-form edge a few miles south of it. In several localities European geologists have treated the saliferous and cement rocks in such a manner, as greatly to perplex their readers. From such perplexities the only relief is afforded by treating them as interposed strata, deposited in the middle of the lower secondary class, or third series.

Remark, 2. I have been much perplexed, and have equally perplexed my students, with the lower strata of the lower secondary class. I find that the best European geologists are equally misled, and have misled their readers in this country, by mistaking the true position of the cherty (corniferous) limerock. I intend to prepare an article on that subject for the Journal of Science, as soon as my time will permit. At present, I state the following:

The shell-limerock at Trenton Falls, north of Utica, is the uppermost transition stratum, as appears by its embraced relics, and by other characters. The carboniferous slate (2d graywacke slate) overlays it on its western side, and extends by way of Utica to a fall on Starch-Factory Creek, five miles south of that city. This is the lower stratum of the lower secondary class, as appears from its organic contents. At the fall last mentioned, the millstone grit rests upon it. Those two strata may be traced until they are found to pass under the cherty limerock, which extends from Black Rock on Lake Erie, by way of Auburn through Madison county, Otsego county, to the top of the Helderberg at Pucker Street, 22 miles south-west of Albany. So far this rock continues at nearly the same general level. From the place referred to on the Helderberg it descends suddenly to the eastern foot of the mountain, and forms Bethlehem caverns. And though it is more than twenty miles distant from the transition limerock at Trenton Falls, where it passes through the counties of Madison and Otsego, the distance between the two limerocks does not exceed the fourth of a mile in Bethlehem ; and in CatsKill, Greene county, they come in contact. The millstone grit, the saliferous rock, the ferriferous rock, the hydraulic limerock, &c. which are interposed between them near Utica, having been totally discontinued—leaving a stratum of the 2d graywacke (grit slate) about 60 feet thick at Bethlehem, and nothing to separate them at Catskill.

From Catskill the transition and secondary limerocks extend south in contact by way of Kingston, and along the Hudson and Delaware Canal to Delaware river, and thence onward into the state of Pennsylvania.

Similar parallelisms and divergencies have probably misled European geologists. Hence the confusion in different authors respecting their mountain limestone, transition limestone, cherty limestone, Jura limestone, metalliferous and carboniferous limestone.

In our district the organized remains afford an all-sovereign remedy. After the most dilligent search, we find no interference in the organized remains of the two rocks, whether distant or near. I traced the cherty (corniferous) limerock, in company with my students in July, 1831, from the top of the Helderberg to Pennsylvania—a distance of one hundred and twenty miles. We learned thereby that the cherty limerock of Lake Erie embraces Bethlehem caverns and underlays all the coal-measures of Pennsylvania. Consequently the Alleghany and Catskill Mountains are chiefly 3d graywacke—being the lower part of the upper secondary class, or series IV. Our upper secondary rocks are always coarser, harder, and wear a more primitive aspect than their equivalents in Europe. But their organized remains and order of superposition demonstrate their place in the system.

DESCRIPTIONS OF STRATA, ACCORDING TO THE FOREGOING SYNOPSIS.

CLASS. I. *Primitive or first Series.*

1. Carboniferous or slaty, formation.

GRANITE, is an aggregate of angular masses of quartz, felspar, and mica. Subdivisions. It is called *crystalline* (granite proper) when the felspar and quartz present an irregular crystalline, not a slaty, form. It is called *slaty* (gneiss) when the mica is so interposed in layers as to present a slaty form. Varieties. It is *graphic* when the felspar is in a large proportion, and the quartz is arranged in oblong masses, so as to present an appearance resembling Chinese letters. It is *porphyritic* when spotted with cuboid blocks of falspar. This variety is peculiar to the slaty division.

Localities.—McComb's Mts.* At West Point we find as extensive layers of crystalline granite, as at any place which I have visited. Here it always alternates with the slaty subdivision (gneiss.)† It is the same at Chesterfield, Goshen, Southampton, Russel, Litchfield, Norfolk, &c. in Mass. and Conn. These and numerous other localities, seem to authorize the adoption of the opinion of De Witt Clinton, LL. D. Professor Nuttal, and several Europeans, who prefer including the granite and gneiss of Werner under the general name granite. Varieties. *Sandy*, at Little Falls. *Porphyritic*, in Johnstown, Montgomery county, N. Y., Litchfield, Connecticut; Chester, Massachusetts. *Graphic*, in

---

* In the month of August and September, 1828, Lieut. Day, at the request of Dr. Zina Pitcher, collected a series of rock specimens from lake Huron to Montreal, on both sides of, and upon, the mountain ridge, which runs along the north side of the great chain of lakes. These specimens I have before me. Also a suit collected by Dr. Pitcher himself, presenting the entire geology of the whole circuit of Lake Superior. I am now prepared to inform American geologists, that the McComb Mt. range of primitive rocks extends in a northwest direction, forming the north-eastern boundary of the great lakes; at least to the distance of one thousand miles from the St. Lawrence at Ogdensburg.

† Lieut. Mather of the Military Academy says, that he found no granite proper (crystalline granite) in the line of his transverse section from Killingly to Haddam, Conn. nor in the Highlands on the Hudson, excepting beds and veins.

Litchfield, Conn. and Southampton mines. Contents. *Steatite*, and *Serpentine* in Savoy and Westfield, Mass. *Diallage*, Lake George. *Magnetic iron ore*, Crown Point on Lake Champlain. *Plumbago* in beds almost co-extensive with the stratum.

2. MICA-SLATE, is an aggregate of grains of quartz and scales of mica. Subdivisions. *Compact*, when the slaty laminæ are so closely united, that it will present an uniform smooth face when cut transversely. Columns, or piles, of hexagonal laminæ of mica are sometimes found in this subdivision. *Fissile*, when the laminæ separate readily by a blow upon its surface.

Localities. *Compact*, on the Boston stage road between Worthington and Chesterfield, and between Shrewsbury and Northborough, Massachusetts. *Fissile*, in Conway, Mass. Contents. *Staurotide*, Litchfield, and Goshen, Connecticut. *Sappare*, Chesterfield, Massachusetts; Chatham, Connecticut. *Garnet*, every where, and often *plumbago*.

HORNBLENDE ROCK, is an aggregate, not basaltic, consisting wholly, or in part, of hornblende and felspar. Subdivisions. *Granitic*, when it presents the appearance of crystalline granite with hornblende substituted for mica. *Slaty*, when of a rifty or tabular structure. Varieties. *Gneisseoid*, when it resembles slaty granite (gneiss) with scales of hornblende substituted for mica. *Greenstone*, when of a pretty uniform green colour, and containing but a small proportion of felspar, generally of a slaty structure *Porphyritic*, when spotted with cuboid masses of felspar. *Sienitic*, when speckled with small irregular masses of felspar.

Localities. *Slaty*, east part of Becket, Mass. Butterhill, in the Highlands. *Granitic*, Dalton, Mass. Highlands, adjoining the granite. Varieties. *Gneisseoid*, Dalton, Mass. Butterhill, Highlands. *Porphyritic*, Conway, Plainfield, Buckland, Mass. *Sienitic*, Clip Hill, Johnstown, N. Y. and near Boston, Mass. Contents. *Granite*, in veins, Belchertown, Mass. *Actynolite*, Cummington, Mass. *Augite*, Lake George, N. Y. Rarely *plumbago*.

Talcose Slate, is an aggregate of grains of quartz and scales of mica and talc. Subdivisions. *Compact*, having the laminæ so closely united that a transverse section may be wrought with a smooth face. When the quartzose particles are very minute and in a large proportion, it is manufactured into scythe-whetstones, called Quinnebog stones. *Fissile*, when the laminæ separate readily by a blow upon the surface. Varieties. *Chloritic*, when coloured green by chlorite In some localities the chlorite seems to form beds ; or rather the rock passes into an aggregate, consisting of quartz, mica, talc, and a large proportion of chlorite. Vast beds of pure chlorite are embraced in this rock on Deerfield river, in Florida, Mass.* and in Windham. Vt.

Localities. *Compact*, east side of Saddle Mountain range. *Fissile*, on the west side of the same range. Variety. It is highly coloured with chlorite in the east part of Savoy. Contents. *Chlorite*, in beds in Florida, Mass. containing octahedral crystals of iron ore, also, near Williams College, Mass. It contains gold in the Carolinas, and probably throughout its whole range by way of New-York, to Canada.

Remark. These four Strata are mostly slaty. In truth the crystalline granite, granitic hornblende, and sienite, may be called beds, without doing violence to propriety or language. Plumbago, which is mostly carbon, is found in beds in these strata—chiefly in slaty granite. As these strata alternate with each other continually, they may be considered as cotemporaneous, and constituting one formation.†

---

*I have examined the talcose slate of Florida, Mass., where it crosses Windham, Vt. It does, absolutely, pass into the soapstone quarry of that town; which is green near its western side, eighteen miles west of Connecticut river. From fourteen to eighteen miles west of Connecticut river are the most extensive manufactories of this quarry stone, probably, in the world. This stone is certainly a compact variety of the talcose slate of Massachusetts, extending to this place. The beds of soapstone in slaty and crystalline granite, both at Westfield and Savoy, Massachusetts, are always connected with serpentine, and differ considerably in the silvery lustre of the scales of talc.

† From the top of the Green Mt. in Vermont, to the Atlantic (a dis-

2. Quartzose formation.

GRANULAR QUARTZ, consists of grains of quartz united without cement Subdivisions. *Compact*, when it consists of fine grains, so as to appear almost homogeneous; generally in large rhomboidal blocks. *Sandy*, when the grains are so slightly attached as to be somewhat friable. Varieties. *Translucent*, when it is so compact and homogeneous as to transmit light. *Yellow*, when slightly tinged with iron (probably a carbonate.) *Ferruginous*, when an aggregate of minute crystals is strongly coloured yellow or red with the carbonate or peroxyd of iron.

Localities. *Compact*, adjoining the east side of Saddle Mountain range. *Sandy*, on the west side adjoining the granular limestone. Varieties. *Translucent*, Snowy Mountains in Wallingford, Vt. *Yellowish*, most common. *Ferruginous*, Bennington, Vt. Pittsfield, Mass. Contents. *Hæmatite*, in Dalton, Massachusetts, three miles south of the village. *Manganese*, in Bennington, Vt.

3. Calcareous formation.

GRANULAR LIMESTONE consists of glimmering grains of carbonate of lime united without cement. Subdivisions. *Compact*, when it consists of grains of nearly pure carbonate of lime, so closely united that it will take a polish. *Sandy*, when grains of quartz are aggregated, with the grains of carbonate of lime, but so loosely as to be somewhat friable. Varieties. *Dolomite*, when it consists in part of magnesia, and is friable. *Verd-antique*, when it is variegated in colour by the presence of serpentine, giving it more or less of a clouded green.

Localities. *Compact*, Stockbridge, Mass. *Sandy* west side of Pittsfield, Mass., on the Albany stage road. Varieties. *Statuary Marble*, Stockbridge, Mass.

---

tance of about 120 miles) the *general alternations* are as follows. Slaty granite occurs 4 times, mica-slate 3, honblende slate 7, talcose slate 7. Sub-*alternations* are very numerous also. Dr. Emmons counted 20 alternations of hornblende slate and talcose, in half a mile, in Chester, Mass. See Am. Jour. Sci. V. 17, p. 334.

Dolomite, Barrington and Sheffield, Mass., Milford, Conn. Contents. *Tremolite*, Canaan, Conn. *Serpentine* and *chromate of iron*, Milford, Connecticut.

CLASS II. *Transition or Second Series.*

1. Carboniferous or slaty, formation.

ARGILLITE, is a slate rock of an aluminous character, and nearly homogeneous, always consisting of tables or laminæ whose direction forms a large angle with the general direction of the rock. Subdivisions. *Clay Slate*, when the argillite is nearly destitute of all grittiness, and contains no scales of mica or talc. *Wacke Slate*, when it is somewhat gritty and contains glimmering scales of mica or talc. Varieties. *Roof Slate*, when the slate is susceptible of division into pieces suitable for roofing houses and for cyphering slate. *Glazed Slate*, when the natural cleavages are lined with a black glazing.—This variety contains anthracite coal and ferns, also a few animal remains near its upper surface.*

Remark. I should not be disposed, at present, to oppose an opinion, *that we have a primitive, and a transition stratum of clay slate, in contact.* Two miles west of Bellows' Falls, on the Vermont side, clay slate is wedged in between mica-slate on the west, and talcose slate on the east, agreeing in character with Williamstown mountain. The tables or laminæ, are vertical, precisely agreeing with those of the enclosing rocks. The stratum is 2 miles in thickness.

Localities. Clay Slate, Williamstown Mountain range, the bed and banks of the Hudson. *Wacke Slate*, overlaying the clay slate, most of the way from Massachusetts line to three miles west of Cohoes Falls, in New-York. As this slate takes the same inclination with the clay slate, and differs widely from the horizontal (or 1st) graywacke; and as their meeting can never be ascertained, I have presumed to join them. Varieties. *Chloritic*. Both of the divisions are often coloured green by the chlorite in Rensselaer county. *Roof Slate*. That which splits freely into roofing slate, Hoosic, Chatham, N. Y., Water Gap of Delaware river, Pa. *Glazed Slate*, banks and beds of the Hudson from Fort Miller to near Newburgh. Water Gap of the Delaware. *Chloritic*, *red* and *purple*, varieties frequently occur near its junction with the primitive rocks. Contents. *Silicious Slate*, nearly black, and of different shades of green, in the glazed variety at Troy and a few miles below Albany, in extensive beds. *Basanite*, in the glazed slate near Hudson, Troy and Albany. *Anthracite*, beds in Newport, R. I, in Worcester, Mass. in Fort Miller, Troy and Fishkill; and in small quantities along the Hudson River, for eighty miles. The borings at Ballston and Albany, about forty miles apart, are made in the same layers of argillite; and carbonated water is found in both places. See Mrs. Griffith's Essays.

---

* We found a specimen of Orthocera in the glazed argillite at the north end of Troy; but it was lent to the late Mr. Bogert of New-York, and unfortunately lost, before we had the means of ascertaining the species. A species of Terebratula and Mytilus are found in the wacke division in the bed of the Champlain Canal, between Waterford and the Mohawk. Also the Nuttainia concentrica, an Orthocera, Trilobus, Encrinus, Pentacrinus, and some vegetable impressions.

2. Quartzose formation.

First Graywacke, is an aggregate of angular grains of quartzose sand, united by an argillaceous cement, apparently disintegrated clay slate, spangled with glimmering scales; and is never above the calciferous sand rock or metalliferous lime-rock. Subdivisions. *Graywacke Slate*, when the grains are so fine as to give the rock a homogeneous appearance, and is susceptible of division, into thick or thin tables, by natural cleavages. *Millstone grit and grey rubble*,* when the grains are in part coarse, and more or less conglomerate, either white or grey, often very hard. Both subdivisions are often coloured green by chlorite.

---

* *Rubble* being an uncouth word, but too well established to be rejected, I will state: that in common English it signifies a hard grey stone, in roads, of a spheroidal form, which causes the rumbling and jolting of carriages. Kirwan calls these stones, common graywacke, as opposed to graywacke slate.

Localities. The *slate* is nearly horizontal, and lies immediately on the inclined edges of the argillite,* from Canada to Georgia. It is remarkably curved and bent on the Mohawk, between the Cohoes and Schenectady, at Saratoga Lake, and at the entrance of the Delaware and Hudson canal. This irregularity in the direction of the layers, seems to be the result of a (crystalline) tendency of the two rocks to maintain their respective directions. *Millstone grit*, the whole of Shawangunk Mts. *Gray Rubble*, the highest ridges between Massachusetts line and the Hudson. Contents. *Milky quartz* in the eastern part of Rensselaer county, accompanied with chlorite. *Calcareous spar and disseminated anthracite* (never in beds) throughout its whole extent. It becomes an excellent quarry stone in many localities; and in others it is brittle and irregular. Often red and sandy.

3. Calcareous formation.

SPARRY LIMEROCK, consists of carbonate of lime, intermediate in texture between granular and compact; and is traversed by veins of calcareous spar. Subdivisions. *Compact*, when the masses or blocks, between the veins of spar are sufficiently homogeneous and uniform to receive a polish. *Slaty*, when the rock is in slaty tables or laminæ, with transverse veins of calcareous spar. This rock is often cut into very small irregularblocks by the spar, which gives it the name of checkered rock.

Localities. *Compact*, about New-Lebanon Springs. *Slaty*, three miles south of the springs on the Hudson turnpike. Variety. *Checkered rock*, on the Little Hoosick, and near New-Lebanon Springs. Contents. *Chlorite* and *Calc spar*, every where.

CALCIFEROUS SANDROCK, consists of fine grains of quartzose sand and of carbonate of lime, united without cement, or with an exceeding small proportion. Subdivisions. *Compact*, when the rock is uniform, or nearly so, without cells or cavities. *Geodiferous*, when it contains numerous geodes, or curvilinear cavities; which are empty or filled with calc spar, quartz crystals, barytes, authracite, or other mineral substances different from the rock. Varieties. *Oolitic*, when it consists in part of oolite, of a dark colour, and harder than the kind which is common in the lias or oolitic formation of Europe, New-Jersey and Ohio.

---

* The European books tell us of a change in the direction of strata at the meeting of the lower and upper secondary—in which the latter rests horizontally on the inclined edges of the former. In North America, this change takes place at the meeting of the Argillite and first Graywacke. All our strata, above that meeting, are nearly horizontal.

Localities. *Compact*, Flint Hill. *Geodiferous*, at Flat Creek, west of the Noses. Varieties. *Oolitic*, near Saratoga Springs. *Sparry*, at Flat Creek. *Quartzose*, on the north side of the Mohawk, opposite Flat Creek. Contents. *Concentric concretions*. near Saratoga Springs. *Sulphate* of *barytes* and *anthracite*, on the West Canada Creek, six miles above its mouth, also at Little Falls. *Semi-opal*, connected with the quartzose variety. *Brown spar* and *Hornstone*, at Flint Hill. Coarse agate in large quantities, and fine fortification agate in small quantities, at Flint Hill, and in the north hill opposite Spraker's Basin on the Mohawk. Also numerous quartz crystals with pyramids at each end and containing anthracite, in the same locality and near Rensselaer School in Troy. In some, anthracite is seen floating in a limpid liquid.

METALLIFEROUS LIMEROCK, consists of carbonate of lime in a homogeneous state, or in the state of petrifications. Subdivisions. *Compact*, when it contains but few petrifactions and is susceptible of a polish. *Shelly*, when it consists of petrifactions, chiefly. Variety. *Birdseye marble*, when the natural layers are pierced transversely with cylindric petrifactions, so as to give the birdseye appearance when polished.

Remarks. These three calcareous rocks, though very distinct in some localities, often pass into each other; and may, perhaps, be considered the same simultaneous deposite. But the lower side of this last described rock is mostly compact; and the upper and lower side differ in their organized remains. The lower side contains the encrinus transversus, lithodendron dichotomum and plicatum, and others, which I have not found in the upper side. The upper side is shelly, and contains Fungia discoidea and polymorpha, and others which I have not found in the lower side.

Localities. Compact, on East Canada Creek, Otsquago Creek, and west of Little Falls. *Shelly*, Trenton Falls, north of Utica, Glenn's Falls, twenty miles north of Saratoga Springs. Variety. *Birdseye marble*, is the compact, to which, when polished, the vertical encrinites give a birdseye appearance.

CLASS III. *Lower Secondary or Third Series.*

Remark. *Second Graywacke* is an aggregate of grains of quartzose sand, less angular than those of first graywacke, and generally contains some fine grains of limestone. It can scarcely be distinguished from first graywacke in hand specimens ; but it is always above calciferous sand rock and metalliferous lime rock. It is divided into the *grit slate* (2d graywacke slate) containing small quantities of coal ; and *millstone grit and rubble.* It is therefore properly referred to the first and second formation of this series.

1. Carboniferous, or slaty formation.

SECOND GRAYWACKE SLATE, is sometimes gritty, and contains a few glimmering seals ; but it is often a soft slate and dark brown. It rests upon the shelly kind of transition limerock, and is the lowest of our secondary strata. It contains thin layers of coal, of the anasphaltic kind in this country ; but does not seem to be distinctly described in European books. *Localites.* The city of Utica stands upon this rock ; and it extends unbroken from Salmon River, on Lake Ontario, to Little Falls. Then inclining around the Falls on the south side, extends into Albany county. See Remark 2d, following the synopsis.

2. Quartzose formation.

MILLSTONE GRIT AND RUBBLE are composed of quartzose pebbles and grains cemented together ; often very hard. They can scarcely be distinguished, in hand specimens, from the grit and rubble of first graywacke. *Localities.* The millstone grit may be traced from Lake Ontario to Utica, overlaying the second graywacke slate, See Remark 1, and 2 following the synopsis.

Remark. A distinct stratum called *old red sandstone*, and another called *millstone grit*, have been given by most geologists. But the latest European geologists very properly reject them. Because the red sandstone is found passing into all the three graywackes, and the millstone grit is found passing into all the three grey rubbles; not as strata meeting at their surfaces, but as continuous rocks. I shall, however, describe the *red saliferous rock* in its proper place, as separate from the second graywacke; though I may hereafter follow those who may unite it with the second graywacke.

3. Calcareous formation.

GEODIFEROUS LIMEROCK, consists of carbonate of lime, combined with a small proportion of argillite or quartz in a compact state, mostly fetid, and always containing numerous geodes. Subdivisions. *Swinestone*, when it contains very little or no quartzose sand, is irregular in structure, fetid and abounds in geodes. *Sandy*, when it contains quartzose sand, is stratified, scarcely fetid, and contains but few geodes.

Localities. Swinestone is found in the bed and the banks of the Erie canal near Genesee river, and extending one mile east. The canal at Lockport is cut through this rock to the depth of nearly thirty feet for two miles. It forms the upper part of Niagara Falls to the depth of seventy feet. The *Sandy division* overlays the swinestone. Its characters are well exhibited at Black Rock, immediately under the corniferous limerock. Here it contains malachite and magnesia, as constituents. Specimens of this rock, after lying a year in a damp cellar, shoot out numerous crystals of Epsom salts.—Varieties. The *fetid* can scarcely be considered a distinct variety. The darker the colour, the more fœtid the odor. Contents. The geodes contain *sulphate* *of strontian, granular gypsuum, laminated selenite, anhdrous gypsum, fluor spar* in limpid cubes, *arragonite, dog-tooth spar, brown spar, and waxy blende. Galena* has been found in small masses imbedded in this rock, and *bitumen* has been observed in exudations upon its surface, and in geodes.

CORNIFEROUS LIMEROCK, consists of carbonate of lime, embracing [illegible] hornstone, and numerous species of petrifactions, called stonehorns (Cyathopyllum). Subdivisions. *Compact*, when the rock is close-grained; and it generally contains hornstone in layers. *Shelly*, when it consists of shells and contains hornstone in nodules or irregular masses.

Localities. Black Rock affords an excellent locality of the compact, and Auburn, behind the state prison, presents a most perfect locality of the *shelly*. This stratum has been traced from Lake Erie to the Helderberg in Albany county. It has been traced up the Cayuga and Seneca Lakes; and from the head of the latter, up Catharine Creek. But it has not been traced under the Tioga coal beds; though Mr. Hughes found it at a level which seemed to demonstrate that it must run several hundred feet beneath that formation. If so, the anasphaltic coal of Carbondale and the bituminous coal of Tioga, are in the same carboniferous formation. Its remarkable descent at the Helderberg, gives us a solution of the problem proposed in the preceding edition. I mean, that this rock covered a district along the south side of the canal line about 30 or 40 miles in breadth, at an elevation, no where observed in Pennsylvania, consequently its farther extension or termination demanded a solution on Wernerian principles. See 2d Remark after synopsis.

In Europe coal contains more or less bitumen in the same stratum. The proportions of bitumen are so varible, that it does not imply anomaly to suppose, that the anasphaltic coal of Carbondale and the bituminous coal of Tioga, belong to the same carboniferous formation.

This stratum is called carboniferous limestone by Conybeare—a name both inappropriate and unnecessary according to Bakewell and common sense. Carboniferous should be limitted to the slate containing coal. Besides, the primitive, the transition, the corniferous and cherty, limerocks are overlayed alike by slate containing coal. It is often confounded with transition limerock (metalliferous of Bakewell) when the interposed strata are wanting. But the two strata are remarkably distinct if attentively examined, in reference to their respective organic relics, their texture, and relative positions.

CLASS IV. *Upper Secondary or Fourth Series.*

Remark. *Third Graywacke*, is an aggregate of grains of quartzose sand and pebbles, less angular than those of first and second graywackes, and generally contains fine grains of limestone; and contains *iron pyrites* at greater or less intervals, therefore called *pyritiferous slate* and *grit*. It is always above the cherty limerock.

1. Carboniferous or slaty formation.

THIRD GRAYWACKE SLATE, is sometimes gritty; but often soft. It rests on the carboniferous limerock of Foreign Geologists, who often call it grit-slate—also carboniferous slate, as it embraces the great coal-measures.

Localities. On the south shore of Lake Erie, on both shores of Seneca and Cayuga lakes. It embraces the bituminous coal of Tioga, and the bituminous shale and thin layers of the same coal near the heads of Cayuga Lake, Lake Erie, &c., also the great anasphaltic coal beds of Pennsylvania, as appears by careful investigation made in the summer of 1831 during the annual tour of Rensselaer School. Nodules of a kind of wacke are often found in the soft slaty kinds, which contain bitumen in a waxy state.

2. Quartzose formation.

MILLSTONE GRIT AND RUBBLE, are composed of quartzose pebbles and grains, cemented together; often very hard. They can scarcely be distinguished in hand specimens, from the grit and rubble of the first graywacke.

Localities. Millstone grit and rubble form the uppermost deposite of most of the high ridges of the Allegany and Catskill Mountains. It is often wanting in the lower parts, leaving the next calcareous deposite to rest immediately on the third graywacke slate or grit, as near Pucker street on the Helderberg.

3. Calcareous formation.

Oolitic Rocks, are aggregates, which contain more or less of carbonate of lime of an earthy texture, either compact and white (chalk), sandy and greenish (chlorite chalk, green-sand) in minute concentric spheres (oolite) combined with fine grains of quartz, (silicious) or made up chiefly of fragments of coralline (coral rag).

Localities. Silicious limestone is found in place, in fields or in large boulders, every where on the western ridges of the Alleghany, over the third graywacke. They are generally dark-brown or black, and the limestone part is disintegrated at the surface, leaving the quartz only; which seems to be blackened by the disintegration of the pyrites. It appears to be a variety of the pyritous grit; being the lowest of the calcareous deposite resting on the 3d graywacke at Lake Erie and other places. *Oolite* has been found in the town Franklin, Bergen county, N. Jersey, by Dr. Horton—also in Ohio state. The white *chalk* has not hitherto been found in America: but it abounds in various parts of Europe, associated with the silicious limestone and oolite. Chloritic chalk, called green sand, is found in large beds in the marly clay of New Jersey, near Middletown Academy, &c. It contains organized remains peculiar to the upper secondary series, (as ably shewn by Dr. Morton). As a few tertiary relics are found in it also, and as it appears to be embraced in tertiary marl, these masses of green sand seem to be upper secondary deposites embraced in the tertiary; a common occurrence among approximating strata. The coral rag of Coral Cave on the Helderberg, and the underlaying grit-slate and shell grit, and the grit-slate of Livingston cave, are very interesting and instructive. The millstone grit of this series is wanting on this part of the Helderberg; but the calcareous formation is very perfect. The slate which embraces the coal of Carbondale, can scarcely be traced to this place; though its underlaying cherty limerock is the same, (called carboniferous limerock by Conybeare).

CLASS V. *Tertiary, or Fifth Series.*

1. Carboniferous formation.

PLASTIC CLAY, that kind of clay, generally called potter-baker's clay, which will not effervesce with acids. When it is white it is called pipe-clay.

Localities. On the south side of the Bay of Amboy in N. Jersey in a vast stratum of many miles in extent. It appears near the water-edge of Lake Champlain at Crown Point, &c. The pipe-clay variety is seen, like a bank of snow, at the west end of Amboy Bay.

MARLY CLAY, that kind of clay, which will effervesce with strong acids. It overlays the plastic clay aforesaid, when it embraces, near its lower surface, the lignite, iron-stone, bog-ore, iron pyrites, &c. Farther east (in New-Jersey) it embraces a kind of marl, as it is called (green sand or chlorite chalk) which contains numerous animal remains, vertebrated and invertebrated. The marly clay does not often contain organic relics. Even in New-Jersey it contains no organic relics, where the marl-beds are wanting. The iron, both bog-ore, and iron-stone, are found in all parts of this stratum from Lake Champlain to Green county, on the west side of the Hudson, a distance of about 100 miles.

Localities. This stratum is almost universal. It is found in every part of the earth when it is sought in situations where it is not subject to be washed away. It always, probably, contains muriate of lime; consequently, all wells dug in it contain hard waters.

MARINE SAND AND CRAG. The *sand* consists of fine grains of quartz, not united by adhesion or cement; but in loose masses which may mostly be poured—the *crag* consists of pebbles, clay and loam, either united by carbonate of lime or iron cement, as *pudding-stone;* by clay and iron cement, as the *hard-pan*; or not united, being merely *stratified gravel;* or united by adhesion, as the *arenaceous coucretions* near Troy on Green Island.

Localities. The *marine sand* occupies a broad strip on the west side of Hudson river, from near Lake Champlain to Green county; a distance of one hundred miles—also the north part of New-Jersey, most of the eastern part of the Southern States, the valley of the Mississippi, excepting where the diluvion and post-diluvion have been substituted, &c. According to Dr. E. James, the marine *sand* and *crag* extend over about four hundred thousand square miles of the great desert between the Mississippi and the Rocky Mountains.

SHELL-MARL, is in insulated or continued layers, fields, or patches, in almost every part of the earth. It generally reposes on marine sand or crag in all bottom grounds; particularly in graywacke districts, as in every part of the Catskill and Alleghany range. It is still more abundant in the western valleys of New York, Mississippi, &c. It may be seen in depressions on primitive rocks, as in Pittsfield, Mass., &c. It consists chiefly of broken, pulverized, and entire shells, of the genus *helix* (genera *helix*, *planorbis*, and *lymnea* of Lamarck.) Calcareous tufa is often in beds in the shell-marl; which proves it cotemporaneous with it. Consequently the embraced plants of this tufa are antediluvial. But tufa is *now* forming in many localities.

Subordinate Series, embraced in the third Regular series.
(Lower Secondary).

Remarks. [See Remark next after the Synopsis.] These three strata embrace some of our most useful minerals. Salt, gypsum, iron, hydraulic cement, are afforded by them in unlimited quantities. Stretching along the banks of the great Erie Canal, for about two hundred miles, they are the source of incalculable wealth. Their equivalents are found in Europe; excepting that this iron formation is there found in limited beds only. It being a narrow strip, of great length; to give it a regular place in the general series, is calculated to confuse the student.

1. Carboniferous and quartzose formation.

SALIFEROUS ROCK, consists of red, or bluish-grey, sand or clay-marle, or both. The grains of sand are mostly somewhat rounded, and all the varieties of this rock, in some localites, form the floor of salt mines and salt springs. Subdivisions. *Marl-slate,* when the rock is soft slaty, and contains minute grains ot carbonate of lime. *Sandy,* when it is solid blocks or layers, consisting of red or bluish-grey quartzose sand. Varieties. *Grey-band,* the uppermost layers of bluish-grey sand-rock. *Conglomerate,* (breccia) consisting chiefly of rounded pebbles, red, grey, or rust-colour, as under the superincumbent rocks at Mount Holyoke, the Palisadoes, on the Hudson river, &c.

Localities. Its bassetting edges lie directly on the millstone grit. Both divisions, and all the varieties, but the conglomerate, may be seen at Genesee Falls and in the banks of the Niagara river; also at Oak Orchard Creek. The conglomerate and sandy varieties are seen on the Connecticut river, and at New-Haven under the bsaalt; also on the Hudson above New-York under the Palisadoes, and on Catskill Mt. Salt springs are found in it every where west of Rome; but none have been discovered under the basalt of this country.

Remarks. I do not know, that I am authorized; but I am inclined to treat as equivalents, the red sand-rock and breccia under the basalt, at Mineral Hill in Blenheim, and on Catskill Mt. I find the encrinus giganteus in all of them; though the whorls are often indistinct or not manifest. They are most perfect at Oak Orchard Creek.

2. Quartzose and slaty formations.

Ferriferous Rock, is a soft, slaty, argillaceous, or a hard, sandy, siliceous, rock, embracing red argillaceous iron ore. Subdivisions. *Slaty,* consists of green, or bluish green, smooth soft slate, generally immediately under the layer of red argillaceous iron ore. *Sandy,* consists of a grey, or rusty-grey, aggregate of quartzose sand rock, in compact blocks or layers, overlaying or embracing red argillaceous iron ore. Variety. *Conglomerate,* consists of rounded pebbles, cemented together by carbonate or oxyd of iron, or adhering without cement.

Localities. It reposes on the saliferous rock every where west of Little Falls. The sandy division lies over the slate, and a layer of red argillaceous iron ore, about a foot or a foot and a half in thickness, lies between them ; or alternates with the layers of one or both. The slaty division is generally green or blue, and very soft. The sandy division is harsh, coarse, and often conglomerate at the top. The softest variety of the iron ore is called reddle, and is used as a paint.

Remarks. This stratum is at least, two hundred miles in length from east to west, and about twenty miles in breadth. The iron is easily separated or reduced, from the ore ; and is excellent for castings.

3. Calcareous formation.

Lower Lias, is an argillaceous limestone, with an admixture of magnesia, iron, and finely pulverized quartz ; forming a compound of homogeneous aspect. Subdivisions. *Argillaceous*, when it approaches the character of clay slate. *Calcareous*, when it approaches the character of limestone. On burning and mixing as in the manufacture of mason's mortar, it becomes a solid cement under water. Liasoi is a better name.

Localities. It extends along the stage road from about 30 miles west of Utica to near Genesee river ; a distance of about 130 miles—also at Lockport in a slaty form under geodiferous limerock. Here it embraces the Brongniartia platycephala. Contents. [*Gypsum* and the *vermicular limestone* are found in beds in this rock and the Saliferous All may be seen at Manlius Centre, along the south bank of the canal. *Shell limestone* beds are common in this stratum. One of the best localities is between the lower Genesee Fall and the one next above it, on the west side.

Remark. This stratum I call Lower Lias, because it presents all the characters of the genuine lias of Europe, is made up of the same constituents, subserves the same useful purpose as hydraulic cement, and has received this name from the manufacturers. But it does not hold the same place in the order of superposition, and does not embrace the same organized remains. The most compact and useful variety contains no organic fossils; but it passes upwards, into a slaty variety, and embraces beds, both of which abound in them. Pseudomorphous crystals, imitating those of muriate of soda (common salt) four inches across, are found in a soft variety of it at Manlius Centre in the bank.

Remark 2, The three strata, which constitute this subordinate series, are nearly co-extensive in length and breadth—the saliferous exceeding the other two, by a few miles. The whole series may be considered as a sabre-form mass, with the south edge compressed between the quartzose and calcareous formations of the third series (lower secondary) and the north obtuse edge cropping out near Lake Ontario.

ANOMALOUS DEPOSITS.

I. Volcanic. Subdivisions. Basalt, which is called *Amygdaloid*, when amorphous, of a close texture, but containing cellules, empty or filled. When the amygdaloid has a warty appearance and resembles slag, it is called *toadstone*. *Basaltic breccia, or trap-tuff*, is a name given to underlaying rocks, consisting of pebbles and angular grains cemented together; sometimes made up of basaltie grains mixed with red sand-stone. *Columnar basalt*, is presented in prismatic polygons more or less regular. The texture is more granular than amygdaloid, and less so than trap-tuff. The felspar, and often quartz grains, may be distinguished from the hornblende base. *Trap-basalt*, resembles the columnar, but is generally in the form of blocks, and in irregular fragments not columnar in form. Lava, is any volcanic production, of recent origin. The chief kinds are Brown lava, when dark-coloured and nearly homogeneous—*Breccioid lava*, when it consists of cemented grains or pebbles—*Trachite lava*, when white or grey; consisting chiefly of melted felspar, as pumice, &c.

Localities, Of the basalt every variety, and almost every imbedded and every dissseminated mineral, may be seen at Deerfield and at Mount Holyoke in Massachusetts; at New-Haven in Connecticut, and at the Palisadoes on the river Hudson. It appears from the observations of Dr. Z. Pitcher, and of Mr. Schoolcraft, that it once existed in large quantities on Lake Superior; and Dr. E. James found numerous table rocks of basalt between the Mississippi and Rocky Mts. The lava in all its varieties, is in abundance at Vesuvius in Italy.

The order of superposition when all these kinds are present, is as follows: *Columnar* at the top; *Trap* immediately under the columnar; *Armygdaloid* next; *Trap-tuff* at the bottom, resting on red sand-stone.*

Diluvion. Deposites made by the deluge. Subdivisions. *Proper diluvion*, along the Erie Canal, from Little Falls to near Genesee River—also under the city of Troy south of the culvert. *Ultimate diluvion*, in all the ancient elevated forests of New-Hampshire, Vermont, Connecticut, &c.

Unstratified Detritus.

III. Post Diluvion. Subdivisions. *Gravel* or *pebbles* forty feet in depth, from the bed of the Hudson from the head of tide water at Troy to near Albany. Seven miles below sediment more or less fine is seen in the bottom of the river. Dr. Hayden, of Baltimore, has given numerous localities of this kind, without any other object than that of giving us simple truth.

Works of art are found in this formation, which distinguish it from diluvion. It is a curious fact, that no works of art are found in the diluvion. It seems to prove, that durable works of art were not common before the deluge; and that pasturage was the chief employment of the ~~netiluvias~~. antediluvians

IV. Analluvion. This is the detritus, formed by the disintegration of the exposed surface of all rocks and remains on or near the place of disintegration. Subdivisions. *Argillaceous*, when the detritus is fine and adhesive. *Granulated* when in coarse grains, or friable. The character of the soil thus made depends on the character of the disintegrated stratum. This is the only kind of soil, which is dependent on the underlaying rock for its character.

---

* I reject the name *Greenstone-trap*, as applied to basaltic trap rocks in obedience to the request of Messrs. Jackson and Alger of Boston. In truth I have derived more instruction on the subject of basalt from the Geology of Nova Scotia, published by those gentlemen, and an accompanying suit of specimens, than from all other sources.

PROOFS.

General Remarks, corroborating the natural distribution of regular geological deposits into five series; each terminating in a Calcareous formation.

First Series, *Primitive Rocks.*

This is truly a natural assemblage ; as all the rocks are destitute of organized remains. The lower (slaty and carboniferous) formation embraces four rocks which are distinct in their constituents and structure ; but these are manifestly cotemporaneous. They alternate with each other continually (not at their approximating sides only, like other rocks) and present every *form of alternation*, and all contain carb~~onate~~ uret of iron. It is true that granular quartz is not always found as the middle formation ; nor granular limerock as the terminal one. If this is an objection, geology cannot be retained as a science ; for every stratum, excepting ~~gneiss~~ gness, hornblende rock, and the upper limerocks, are wanting in some localities. All that Werner's first views promised, and all that our latest geologists now promise, amount to this : "whatever strata are present in any part of the earth, they are governed by an undeviating law of superposition." This doctrine is founded on the universal law that similar* deposites, which were ever made on any part of the earth were made at the same time. But that most deposites are omitted in some places ; or they were removed by water or otherwise, before they became sufficiently indurated to retain their first positions. Alternations of portions of strata, at their approximating sides, is a universal phenomenon. If we cannot assign a cause, the admission of the fact does not militate against the general position, that regularly alternating deposites are cotemporaneous.

---

* *Equivalent strata* is the more common expression, now in use.

In this country granular limerock extends unbroken from Pennsylvania far into Canada; a distance of at least five hundred miles. Throughout the whole extent, the granular quartz is uniformly interposed between it and the primitive slate rocks, on the eastern side, and the argillite forms its western boundary.

It is true, that granular limerock and granular quartz alternate with the primitive slates, particularly with *talcose slate*, near Williams College and Adams; and the same occurs in Europe according to De La Beche. Argillite, (clay slate) too, is wedged in between talcose slate and mica-slate, two miles west of Bellows Falls, similar to localities represented in the Synopsis of De La Beche. But Argillite, similarly situated in Worcester, Mass. contains anthracite and impressions of ferns. And it is in accordance with all opinions to treat argillite as the more recent deposit, geologically the highest; therefore it may have a descending series of primitive rocks on each side. This supposes a primitive range interposed between each of the four north and south ranges of argillite in New England. The same rules must be applied in explaining the alternations of granular limerock and granular quartz; after their true positions have been shewn by a strip of country five hundred miles in length and from four to ten miles in breadth.

SECOND SERIES. *Transition Class.*

We should examine the calcareous termination of each series, when we would attempt to draw conclusions relative to their respective characters. In the transition class (and the rule applies to all the classes above the primitive) a few organized remains, which are similar or nearly related to each other in character, are found in the first and last formations. In the wacke variety of argillite we find the Nuttainia concentrica in great numbers at Waterford N. Y. and we find it in apparently equal numbers in transition limerock at Glenn's Falls. In the same limerock we find the Flustra carbaseoides, also on the east shore of Lake Champlain; and we find, in the silicious slate imbedded in argillite, the same genus, and, I believe, the same species, in the city of Hudson on the bank of the river. But we find no organized remains in the interposed millstone grit—neither do we find any of the relics of this series above transition limerock.

The student should be told, that *all species* of organized remains found in one stratum are not to be expected in similar strata or similar series. Living animals or plants are not common to all similar climates or soils. But if we find one similar species in two rocks, these are to be considered nearly contemporaneous—or rather to have been deposited between the periods of two of those catastrophies, which swept animal and vegetable life from the earth. Such catastrophies were probably the effects of heat; as we are acquainted with no other agent which would have charred the vegetables and destroyed all animal life of both sea and land.

It is somewhat difficult to determine the limit of the calcareous formation of the transition class, upwards. We find resting upon the first graywacke, a calcareous rock traversed and checked by spar—over this is a rock consisting of variable proportions of calcareous rock and quartzose sand—the last is covered by compact and shelly limerock. Though these three strata differ in striking external characters, they are all well characterized by the presence of carbonate of lime. They all seem to have been called Carboniferous limerock by Conybeare, in some localities; in others he unites cherty limerock with them, and in others confines this name to the cherty alone. The limited localities to which his observations were confined caused this confusion; as his observations are exceedingly accurate, when his field of observation was sufficiently extensive. In North America the merest novice will not fail to unite the three, and separate the cherty—the former being the upper limit of the transition, and the latter the upper limit of the lower secondary class.

THIRD SERIES, *Lower Secondary Class.*

Immediately *below* the transition limerock De La Beche, and other foreigners, place a graywacke slate, similar to ours *above;* as that, on which Utica stands.* This rock contains but little coal. In it are found some vegetable fossils. Here we find the Brongniartia carcinodea, in the carboniferous slate, at the Cold Spring. Next above this slate, we find, *here,* a common graywacke (called rubble by Kirwan) which passes into millstone grit. It extends from near Utica to Lake Ontario, and is the true quartzose formation. It passes into red sandstone in some places. It is overlayed by the subordinate rocks, containing, salt, gypsum, &c. The Corniferous limerock terminates this series. It abounds in most interesting petrifactions. Europeans call it cherty, mountain, jura carboniferous, &c. None of its organic remains are found above it; though many of them are found below it in the same series, and none below the series. Productus depressus, is a strong case.

FOURTH SERIES. *Upper Secondary.*

Immediately above the Corniferous limerock (called Carboniferous, Mountain, Cherty, &c.) we find 3d graywacke slate (called slate clay, coal grit, grit slate, &c.) embracing the great coal measures of Pennsylvania, both bituminous and anasphaltic. This is the true carboniferous slate. It presents numerous vegetable impressions; and is overlayed by slate grit (or gritty graywacke) containing invertebral animal remains. Most of these rocks contain magnesia; as appears from the continual production of sulphate of magnesia, in a state of efflorescence. The quartzose formation comes next in the form of Millstone grit, red grit, red conglomerate, rubble, red sandstone, &c. The *calcareous formation* appears at the end of this series, as calcareous grit, Coral rag, Oolite, Chloritic chalk (or green sand). The Asaphus hausmannii is found in Coral rag, and in the [illegible] calcareous grit below. As it is not found above or below this series, it proves its strata to be nearly cotemporaneous.

---

* No European understands his cwn graywackes. See page 93.

FIFTH SERIES. *Tertiary*.

Stratified, or slaty, clay, is the lowest of the uppermost regular series. Lignite (wood imperfectly charred) is embraced in the clay in some localities. Along the south shore of Amboy Bay, it appears in great quantities and very perfect. Quartzose sand and crag are found over the clay (probably of marine origin). Rarely, if ever, contains organic relics, in America. Calcareous shell marle, when present, is the highest of all regular deposits. It consists chiefly of loose shells and fine fragments of them. Scarcely any relics are found in it but Helicites. Often it alternates with stratified tufa, containing impressions and castings of lichens. This series is not so well supported by organic remains, as the preceding. But being almost universal in depressions, though such depressions may be on the highest mountains, analogy seems to be sufficient to entile it to a place in the system.

From this view of the subject, it appears that slate forms the lowest deposite in every series, and contains carbon in some localities in the state of graphite, anthracite, coal, or lignite. And that a calcareous deposite terminates every series. In all the five series, excepting the first, the lowest formation contains vegetable fossils, which grew on the preceding limerock, or its disintegrated soil; also that the terminating deposit contains organic relics, some of which are found in the lower formation, unless the fifth series forms an exception.

PROOFS, *that the coal beds of Pennsylvania, both bituminous and anasphaltic, are equivalent to the great coal measures of Europe.*

The coal measures of Newcastle, upon the Tyne—Saarbruck, &c. contain species of fossil vegetables, which are found in the coal beds of Carbondale, Wilksbarre, and other extensive beds in Pennsylvania. I have before me the NEUROPTERIS *elegans*, *acutifolia*, *auriculata*, *angustifolia*—also the SPHENOPTERIS *artemisaefolia*, *latifolia*, *trifoliata*, *mantellii*, and numerous other species, which the students of this school, and myself, took from Carbondale coal beds last July. All of which, according to M. Ad. Brongniart, are found in the European coal beds before mentioned. He says too, in his history of Vegetable Fossils, that the NEUROPTERIS *scheuchzeria*, *cisti*, *loshii*, and *microphylla*, are found at Wilksbarre, as well as in the European coal measures.

Numerous additional proofs might be adduced from the abundant materials in my possession; but I believe, that no one will question the high authority of Brongniart in this department of nature. After having demonstrated, that the Pennsylvania coal beds are equivalent to those of Newcastle, those near Bath, near Glasgow, at Waldenburg in Silecia, &c., nothing more is required but locomotion, eastward and westward, to understand the order of superposition throughout the whole Alleghany, Catskill, Helderberg, and Shawangunk districts.

The only remaining question is, whether the Pennsylvania coal beds should be called lower secondary, or upper secondary. In the former edition of the text-book, I referred these coal beds to the lower secondary class. Those geologists who consider the coal as appertaining to the cherty (corniferous) limerock; must, with Conybeare, treat it as of the lower secondary class. But, if organized remains are to furnish characteristics, the cherty limerock terminates the lower secondary class upwards; and the slate embracing the coal, is the commencement of the upper secondary series. I have given my collection of facts, in proof of this position, at pages 66, 73, 76 and 79.

I will add, however, that the cherty limerock often alternates with layers or beds of a sandy graywacke at its upper surface, which should be considered as contemporaneous with itself. In Coeymans the ECHINUS *gyricanthus* is fonnd in this sandy alternating rock—in Bethlehem it is found in the cherty limerock. This is not a singular case; for most adjoining rocks alternate and join their characters.

Reasons for adopting three graywackes.

In North America the millstone grit, and a grey sandy and slaty rock beneath it, occur three times; and it is exceedingly difficult to distinguish these rocks in hand specimens, without the aid of organized remains. And remains are almost exclusively confined to the grey rocks. Common quarrymen, farmers, and foreign geologists, apply the names, *graywacke* and *millstone*, to all these rocks promiscuously; neither having observed their different relative positions.

By what names shall we call these rocks? Europeans are not at all agreed in their names. Grit slate, grit stone, slate clay, coal grit, psammite, mimophyre, pyritous shale, are but a part of the names; and these are often confounded and variously applied.

No nomenclature can be more clear and intelligible, than the application of the same name to the three deposites, which are interposed between the *primitive* and *transition*, *transition* and *lower secondary*, *lower secondary* and *upper secondary*, *limerocks*. These three almost similar deposites, may be distinguished by numbers, *first*, *second* and *third graywacke*. Here is no novelty to embarrass the memory, and there is not even the possibility of any confusion or mistake in applying these names.

The resemblance in the characters (or sameness of character) of these three graywackes, including the overlaying millstone grits, may be seen in the following localities. *First Graywacke and Millstone grit.* It is seen resting on the argillite near Col. Worthingston's on the Little Hoosick, near the east line of Rensselaer county. On ascending the western hill or ridge, the graywacke slate, rubble, and millstone grit, are found in succession. This ridge extends from Canada through the state of Vermont, Washington county, Rensselaer and Columbia counties—and crossing the Hudson river it forms the vast mountains of millstone grit, called Shawingunk. Its elevation is much varied, and often sinks down to a level with the adjoining rocks. *Second Graywacke and Millstone grit.* Both rocks are remarkably distinct at the falls on Starch factory creek, five miles south of the city of Utica. The same extends to Lake Ontario, about eighty miles in a northerly direction; terminating near the mouth of Big-Salmon river.

The ridge at the falls is about midway between the transition lime rock at Trenton Falls, and the corniferous limerock (cherty) of Otsego county. It overlays the former and underlays the latter. *Third Graywacke and Millstone grit.* Catskill mountain along the turnpike road to the Mountain House, presents the graywacke slate, the rubble, and the millstone grit. At the bottom of the mountain, two miles west of the village of Catskill, we see the corniferous limerock--being a continuation of the cherty limerock of Blackrock on Lake Erie. We do not see it pass under the graywacke here ; but if we examine the foot of the mountain from 8 to 12 miles further south, we have a fair view of this order of arrangement. The millstone grit on the mountain near the Mountain House passess into a redish and greyish conglomerate. And it is remarkable, that when red, it contains the same encrinus, which is found in our saliferous rock. (My Encrinus giganteus, probably Sclotheim's ramosus.) The Allegany ranges of mountains in Pennsylvania consist of third graywacke, including the grey rubble and millstone grit. The southern part of the Helderberg mountain consists of the same rocks. But near the northern part (perhaps not far north of the middle of the range,) these rocks descend rapidly, become very thin, and finally disappear under the coral rag ; or perhaps they pass into the grit slate, and shell grit. Near Pucker-street on the Helderberg, the last named rocks are very distinctly presented to view, as described in the preceding pages.

Reasons for adopting Geodiferous Limerock..

Some European Geologists, particularly De La Bache, treat the rocks, as of the Red Sand stone Group, which I have called Subordinates to Series III. See pages 65 &c. To this group, De La Bache has added the Geodiferous Limerock ; which is so splendidly exhibited at Lockport on the Erie Canal, and at Niagara Falls. He applies the particular names of the German geologists. For example ; he calls the limerock through which the canal is cut 31 feet deep at Lockport, and the upper rock at Niagara Falls, which is about seventy feet thick by Humbolt's German name, *Zechstein*. The stratified kind, which contains *malachite* (a variety of copper ore) he calls *Kupferschiefer*. There is a remarkable locality of it at Black Rock. It was laid open to view in cutting down the ledge north of Gen. P. B. Porter's house, to accommodate the canal near the outlet of Lake Erie.

This stratum seems to be too limited in Europe to afford a character sufficiently general. In this country it is a vast stratum, and always more or less geodiferous.

The numerous uncouth and vague names given to this rock, surely demand reformation, The following list are of about equal authority. Stinkstein, Rauchwacke, Zechstein, Asche, and Kupferschiefer. Three of them are applied to varieties, which may be better expressed by common adjectives.

We cannot attach it to the Red Sandstone Gronp here, according to De La Beche; because it is rudimentally attached to our Cherty limerock, where there is not a trace of our subordinate series (De L. B's Red Sandstone group). The slaty rock beneath this is very distinct from it. For the slate is a mere variety of our lias, or liasoid, which overlays our Ferriferous rocks, the latter resting on Red Sandstone, or Saliferous rock. I shall only add, that mere inspection will satisfy any one, that our Geodiferous limerock is associated with the Cherty; and that it is not related to our Red Sandrock (Saliferous).

American Lias, Liasoid, Hydraulic limerock, Water cement. Has the stratum, called by these names, any equivalent in Europe?

We have in this country the whole of the Red Sandstone group of De La Beche; consequently the lias. The only question is: Do our strata, which precisely resemble those of De La B's Red Sandstone Group (which I consider as constituting a series subordinate to the Third Regular Series, excepting the Zechstein) hold the same relative grade to age, with the same group on the Eastern continent? We are compelled to unite the Zechstein (Geodiferous limerock) to our Cherty (corniferous) limerock, for reasons heretofore assigned. In

our Subordinate series we have the lower Lias (Water
Ferriferous cement) Firiferous rocks (which may possibly be the lias sandstone [and lias slate] of Pusch) * White sandstone (Grey-band variety of saliferous rock) Red and white shistose sandstone (white and Red Sandy Saliferous slate) Red, White, and Variegated, Marls, and marl slates (saliferous Marl Slate). All these occur in distinct strata of vast extent, between the City of Utica and the western extremity of Lake Ontario—a distance of more than two hundred miles.

So far my statement would seem to demonstrate the equivalent characters of our Subordinates, and the foreign Red Sandstone group. But our Corniferous Limerock (cherty limestone) overlays all this group, and passes under our great coal measures of Pennsylvania, &c. Our coal measures have been shown to be equivalent to those of Europe. Therefore this mode of reasoning places the coal measures above the lower lias and its associates.

Such are the facts; and I leave the verbal criticisms to others. But I suggest another fact, for the consideration of De La Beche and other European geologists. We have certainly seven species of the Cyathophyllum in our Corniferous Limerock—all of which are found in the same rock in Germany. De La Beche gives a out list of organized remains, found in his district, and quotes Goldfuss; but he does quote one of the seven of Goldfuss' species found by him in Germany in this rock, and by myself in the state of New York. Though I state the fact, I do not know, that it will assist in obviating the difficulty.

Note. I have never found any organized remains in our lias—few in our ferriferous rocks, none in the saliferous, but the Encrinus gigigantus (ramosus, Schl) and
giganteus the Lingula mytiloides. But I confess, that my students and myself have neglected to make that dilligent search in these rocks, which the subject requires.

---

* See De La Beche's Manual, p. 378. American Ed.

APPLICATION OF GEOLOGY ;

AS THE BASIS OF THE SCIENCE OF AGRICULTURE.

SOILS.

An error of importance had prevailed among geologists, on the subject of the origin of soils, until a classification of detritus was established. Cuvier's theory of the earth did much towards the present improved state of that department of geological knowledge. But Schoolcraft suggested the first thought ever published, on a classification, which is in accordance with the present views of geologists on that subject; though his nomenclature was different.* Near the same time Conybeare, Buckland, and others, gave a character to it, which will endure.

It seems to be demonstrated, that anti-deluvial detritus (called the tertiary formation) is a deposit, as independent and distinct, as secondary rocks. It cannot be traced immediately to any adjoining rocks. Consequently its character cannot be explained by referring to other strata ; unless we admit the general principle that all deposites, made after the deposition of the lower part of the argillite, consist of fragments of the older rocks.

The principal heretofore received then, that soils depend for their constiutent characters on underlaying rocks, cannot be received any farther than as applied to *analluvion*. All other kinds of soil have characters as independent as transition or secondary rocks ; and they may be classified now, with as much accuracy.

FERTILITY OF SOILS.

1. Fertility of merely earthly soils does not depend on their ultimate chemical elements. Pulverised emery, which is almost pure alumine, will have the same influ-

---

* See my Index to the Geology of the Northern States, 2d ed. 1820.

ence upon vegetation as pulverized quartz, which is nearly purely silex. Hence the reason that Davy, and other distinguished chemists, have disappointed agriculturists by their analyses; which were founded on such mistaken views.

2. The perfection of earthly soils, without any reference to animal, vegetable, or other adventitious matter, requires the following constituents in due proportion: 1. *Stones* and *pebbles* sufficient to keep the soil open and loose. 2. *Clay* sufficient to absorb and to hold water in a just proportion. 3. *Fine sand* in sufficient quantities to prevent the clay from baking into a compact mass, in time of drought. Also to prevent its retaining so much water in the winter season, as, by expansion during the freezing of the water, to draw the roots of vegetables from the earth—called the winter-killing process.

To select a farm for purchasing, or to improve land by artificial means, without the application of manures, requires particular attention to these proportions.

Vegetables receive their chief support from the atmosphere; and the whole of it, when they grow in clean, pure, unmanured earth. Neither dry sand nor baked clay will absorb the nutritious gases. Duly moistened earth absorbs carbonic acid, ammonia, and other nutricious gases, which are received from the soil by the fibrous rootlets, for the use of plants. Charcoal and other carbonaceous matters, absorb these gases with great avidity. Hence the great value of carbonaceous manures, as rotted straw, charcoal, &c. But a due proportion of moisture is essential to absorption in all cases. Hence the importance of an attention to soils in reference to the absorption and retention of water. Hence too the importance of frequently stirring and disturbing the dry surface of the soil, in time of drought, by hoeing, plowing, &c., in order to present a moist surface to the atmosphere; without which, nutritious gases cannot be absorbed.

Carbonate of lime, sulphate of lime, and all the soluble salts, as well as putrifying vegetables and animals, should be considered as manures. They all act, either as absorbents, like charcoal ; stimulants, like gypsum, muriate of lime, &c., or as furnishing nutritious matter by their decomposition, like fish, rotted straw, &c. Therefore the geological agriculturist studies chiefly the proportions of *stones*, *pebbles*, *clay* and *sand*. The study of that part of geology which relates to *detritus*, is the true study of the first principles of elementary agriculture.

By a reference to the system of classification, in the pseceding part of this text-book, it will be seen, that all detritus is distributed into eight deposites. 1. Plastic clay. 2. Marly clay. 3. Marine sand. 4. Shell marl. 5. Diluvion. 6. Ultimate diluvion. 7. Post diluvion. 8. Analluvion. After studying the character of these deposites, nothing more is required than a mere application of common sense to each particular case.

CLASSIFICATION OF SOILS.

1. *Plastic clay*. This stratum is rarely found at the surface of the earth, except at its out-croppings in banks. It is destitute of any material portion of carbonate of lime—being the clay used by potter-bakers. Without any intermixtures, it would bake in the dry season, and be running mortar in rainy weather. Intermixed with marine sand, it would be tolerably productive. Wheat winter-kills in it more than in any other soil.

2. *Marly clay*. (London clay.) This stratum is almost universal in bottom grounds. Alone, it bakes in a drought, and is mortar in a wet season. Wheat winter-kills in it. But it generally contains from fifteen to twenty per cent. of carbonate of lime, and considerable muriate of lime. Wells dug in it, almost invariably furnish "hard waters," on account of the muriate of lime. These salts give it richness. Therefore if it is duly mixed with marine sand (which generally overlays it) it forms rich and very durable soil. From near Lake Champlain to Greene county, on the west side of the Hudson, this clay, overlayed with marine sand, prevails.

Also throughout most of the northern part of New-Jersey, along the valley of the Mississippi, &c. If the vast plains of *marine sand*, between the Mississippi and Rocky Mountains, are generally underlayed with this clay, as they certainly are in some localities, next century may, under the hand of culture, enliven that barren waste with fruitful fields.

3. *Marine sand*. (Bagshot sand.) This stratum alone is a meagre barren soil. But makes an excellent kind when duly intermixed with the marly clay beneath it, as mentioned under marly clay. This stratum often passes into crag, or stratified gravel, hardpan, &c. The crag is a better soil alone, than the sand, excepting the hardpan and some other varieties, wherein the gravel is held together compactly by ferruginous, calcareous or clayey cement. But if duly intermixed with the marly clay, it forms a good soil.

4. *Shell-marl*. This deposite is a most excellent manure, when intermixed with any of the other soils—best with soils in which clay predominates. It is chiefly carbonate of lime; but being made up of broken shells or minute species, it is always in a state suited to its application as a manure. But when alone, it is not very productive, especially in a dry season.

5. *Diluvion*. As this deposite is the most heterogenious of all deposits, it presents the characters of most other soils. In general it is very rich in vegetable manure; but it is often too loose, and requires an artificial intermixture of clay. It presents all its characters along the Erie canal, between the Little Falls and Genesee river. It frequently affords localities of vegetable mould, which may be advantageously carted upon other soils. As it is generally in narrow slips or small fields, the surrounding grounds may receive its benefits with but little carting.

6. *Ultimate diluvion*. This seems to have been a thin universal mantle, covering the earth in the first ages after the deluge. It still remains undisturbed in the most ancient forests. But in all cultivated grounds, has been intermixed with the underlaying soils. In its undisturbed

state, it is the soil to which the word *loam* is most properly applied. Alone, it is a durable and rich soil, excepting where sand predominates. Mixed with other soils, it is always useful.

7. *Post-diluvion.* Near the sources of the waters, which deposited this soil, it is always too coarse and destitute of any fertilizing quality—remote from these sources, it is fine and rich—midway between these extremities, it is middling in character. But post-diluvion is, from the nature of its origin, exceedingly variable—every locality depending on the deposites from which the waters flowed.

8. *Analluvion.* This kind of soil is perpetually forming by the disintegration of rocks, whose surfaces are exposed. Its character depends entirely on the constituents of the rock. Therefore argillite and argillaceous graywacke produce, by disintegration, clay soils. Rubble wacke, granular quartz, and other quartzose rocks, produce sandy soil. Hornblende rocks produce a rich intermixture.* Limestone rocks, particularly argillaceous limestone, as the geodiferous limerocks, produce a rich calcareous and alluminous soil.

Broken fragments of rocks disintegrate and become soils with a degree of rapidity, directly as the superficial measure of surface exposed to the disintegrating agents (water, air, and variation of temperature) is to their quantity of matter. Consequently lands may be suddenly enriched by throwing upon them limerock, hornblende rock, (whether basaltic or primitive) argillite, &c., in a finely pulverized state. Or they may be gradually and permanently enriched by scattering over them broken fragments, one inch, or two inches in diameter. The rock must be selected according to the original components of the soil; so as to supply what appears to be deficient. Tabular spar (a fragile variety of carbonate of lime, or limerock) which abounds along the western side of Lake Champlain, has recently been applied, with astonishing success, in the finely pulverized Fragmented state. In the fagmented state, it had been applied for several years, to great advantage. No farmer is more opposed to mere speculative theory than myself; but facts place the advantages of strewing soils with pulverised rocks and fragments, beyond the reach of speculation.

---

* Dr. E. James observes, (see Long's Expedition, vol. 2, p. 402) that in the midst of the Great Desert, near the Rocky Mountains, where all was "brown and desolate, as if recently ravaged by fire," the hills of greenstone trap, which consist essentially of *hornblende*, were covered with a green turf from their bases to their summits. This is a discovery of more value to agriculture than all that Sir H. Davy ever made; though to the mineralogist and chemist, they are useful. But who knows the modest, the amiable, the excellent Edwin James ? New England might he enriched by an attention to this subject —and would too, had Davy told us this fact.

GEOLOGICAL ANALYSIS OF SOILS.

The chemical analysis of soils, with a view to detect their ultimate elements, has promised much—particularly in the hands of Davy. But it has, in all cases, disappointed the hopes of the practical farmer, for reasons given under Fertility of Soils. It is to the Geologist, not the Chemist, that the practical farmer must look for instruction, so far as *mere soils* are to be considered. The detection and application of stimulating earths and salts (as gypsum, lime, &c.) and of decomposed or decomposable vegetable matters, come within the province of the chemist.

Chemical analysis of soils, like other analysis of mineral bodies, give the ultimate elements in a manner, which is favorable to the pursuits of the student in chemistry and chemical mineralogy. The complicated mixtures of soils afford an excellent field for a trial of his strength in his first essays at analysis. This is, however, widely different from those researches and investigations, which the impatient anxiety of the farmer demands. The student is pleased with results, which evince the correctness of his preconceptions, and the adroitness of his manupulations, regardless of utility.

But those analyses, which belong exclusively to the chemist, detect fugitive and variable materials, which are not to be considered as a part of permanent soil.

They may be varied from year to year at pleasure; and their proportions may be calculated as they are artificially varied, or they may be detected and estimated by the chemist after they are added. As vegetable and animal matter is a geological deposite, easily detected and always present in a greater or less proportion, it should be considered as a part of geological analysis.

Geological analysis of soils may be made, by pursuing the course of geological deposition in miniature. That is, soils may be deposited from water, in the assay glass or a common tumbler, after suitable preparations, so that the proportions of silex, alumine, animal and vegetable matter, water of combination, and power of absorbing, may be shown. These are the most important subjects of enquiry when the object is to improve the soil, or to judge of the best method of culture, or of the most profitable articles to be cultivated on particular fields or farms. The elevation of grounds, above the level of the ocean, and the degree of latitude, are also subjects of great importance. Humbolt's Equivalents, deduced from comparing the effects of high latitudes with mountain elevations, should be duly applied.

Formula for Geological analysis of Soils.

1. Select about one quart of soil which shall appear to be an average of the field. Spread it out and make it as dry as it can be made by the sun's heat, after thoroughly intermixing all parts of it.

2. pulverize it as fine as can be done by rubbing in the hands. Take half of it, and pick out, by the assistance of shaking in a dish, all roots, straws, &c., also all pebbles or grains over the size of a common pin-head.

3. Weigh out, of the finest of it, with accurate scales, three parcels of 200 grains each. First for determining the water of combination. Second for determining the animal and vegetable matter. Third, for determining the silicious matter; or rather, the earthy part which does not combine with water excepting by superficial attraction of adhesion. The same parcel is also em-

Aluminous

ployed for determining the Allumnious part, and the power of Absorption.

gallipot

4. Heat the first parcel in a crucible, or grllipot, constantly stirring it with a dry pine stick, until the stick becomes a little brownish from the heat, when pressed against the bottom of the crucible. Now weigh it, and set down the loss for *water of combination.*

5. Heat the second parcel, stirring as before with a glass rod or slip of window glass, until it is at a red heat, and no glimmering sparks to be seen. Weigh it, deduct the weight of the water of combination, and set down the remainder of the loss for *animal and vegetable matter.*

6. Put the third parcel into a pint of pure water. Stir it repeatedly for about ten minutes. Let it stand precisely three minutes for the silicious matter to settle. Pour off into another vessel, all the supernatant liquid and its contents. Add another pint of water to the silicious sediment. Let it settle just three minutes as before. Pour off all the supernatant liquid again. Dry the sediment about as dry as when weighed. Weigh it and set it down for *silicious matter*.

7. Subtract the sum of the weights of the *water of combination*, the *animal and vegetable matter*, and the *silicious matter*, from 200 grains, and set down the remainder for *argillaceous matter.*

8. Pour into one glass vessel the two portions of supernatant liquid, which had been poured from the silicious matter, and note the time required for settling, so as to leave the iquid clear. Set the time down for *power of absorption.*

Liquid

Analyses made by Dr. T. R. Beck and myself, of soils taken in the vicinity of Albany and Troy.

Upland loam. Absorption, 4 hours in settling—Water of combination, 4 per cent.—Animal and vegetable matter, 5 per cent.—Silicious matter, 68 per cent.—Alluminous matter, 23 per cent.

Best lowland loam. Absorption, 3 hours in settling—Water of combination, 4 per cent.—Animal and vegetable matter, 12 per cent.—Silicious matter, 58 per cent. Alluminous matter 26 per cent.

APPLICATION OF GEOLOGY,

AS THE SCIENCE OF MINING.

The most valuable bodies sought in the earth* with success in North America, are:

1. *Rocks.* Marble, Freestone, Flagging-stone, Wall-stone, Millstone, Grindstone, Whetstone, Hone.
2. *Salt and combustibles.* Table salt, Epsom salt, Gypsum, Barytes, Strontian, Coal, Sulphur.
3 *Ores.* Gold, Iron, Manganese, Lead.
4. *Waters.* Carbonated waters, Sulphuretted waters, Sulphuric acid waters, Muriate of lime waters, and Deer licks.

Experience, alone, teaches us, with what strata these valuable bodies are associated. Therefore a concise enumeration of their best known localities, accompanied with an extended view of their associated strata, will present to the student all that will be useful to him, as illustrative of this application of Geology.

---

* This note should have been included in the text of the last preceding page; but, having been omitted, there is no impropriety in placing it here.

As the earth affords us our own vegetables for clothing and diet, and supplies animals with their living, upon whom we feed and with whose skins and clothing we are clothed, the earthy outside of our planet cannot be too well understood, as applied to Agriculture. The preceding article should be studied, then, as a branch of Geology. And I may here add an average proportion of the common constituents found in the best soils of the kinds enumerated.

If water oozes into loose gravel, sand, or loam, about four feet beneath the surface, as it often does in river alluvion—Absorption, 2 hours to settle—water of combination 3 per cent—animal and vegetable matter 12 per cent—silicious part 76 per cent—aluminous part 9 per cent, it is very productive.

Rich but winter-killing. Absorption, from 12 to 26 hours to settle—water of combination, 4 per cent—animal and vegetable matter 8 per cent—silicious matter 46 per cent—aluminous matter 42 per cent.

Soils are durable and good, consisting of a mixture of ultimate diluvial loam, with argillaceous analluvion, as the common soils of Columbia and Dutchess counties, N. Y. Absorption, 5 hours to settle—water of combination 4 per cent—animal and vegetable matter 6 per cent—silicious matter 68 per cent—alluminous matter 22 per cent.

1. Useful Rocks.

Marble. This name is indefinitely applied to any rock of carbonate of lime, which may be wrought into building stone with the chissel. The most valuable is the Granular limerock. In this country it extends from Canada to Pennsylvania, along the west side of the Green Mountain range. Therefore every farmer, whose lands lie in that range, may probably find on his farm at a greater or less depth, or at the surface, good statuary marble. Good marble has been found, called birdseye marble, in the compact transition lime rocks; also in the shelly kind. But shelly marble will readily disintegrate on exposure to heat; and in time, on exposure to the disintegrating agents.

Freestone. This name has usually been applied to red sandstone. But its application to all saliferous rocks (red, gray, or variegated) is authorized. The freestone of Rochester on Genessee River, is red, grey, spotted, and variously coloured. Saliferous rocks, and red wacke of the first, second, and third graywackes, make good freestone. These stones never crack by heat; but they crumble off or become friable, and ought not to be highly heated.

Flagging stones. The best known in this country are the gneiss, and gneisseoid hornblende. Haddam, Con. affords excellent specimens. West of Worcester, Mass. towards, and in Leicester, the rocks are equally good. They were formerly too far inland. Since the canal is made, they may become profitable. When I first heard of this project, I supposed the value of the stock was to be estimated by the value of these vast ledges of gneiss rock. Why Yankee ingenuity and perseverance does not reach them, I know not. I presume Prof. Hitchcock, the state geologist, will apprize them of their value, in his expected and much desired report.

Wall-stones. This name is applied to stones, which will lie fairly in a wall, with or without chisseling or sawing. It is not necessary that they should bear chisseling, provided they can be broken from ledges in regular parallelopipeds for laying up in a dry wall, or for masoning with mortar. Gneiss, gneisseoid hornblende, and the two lower graywackes, afford more or less good wall-stone. First graywacke, when formative, is always a good wall-stone. It has been sawed and used in Troy with success in the basement story of houses. See Dr. Gale's house. It is remarkable for cracking, and even flying into pieces, when heated; hence it is called *soap-stone* in some districts. Third graywacke is rarely suitable for a wall-stone; for it contains iron pyrites, which often produces rapid disintegration. See some of the Western Locks, and the walls of some houses in Ithaca.

Millstone is a subdivision of graywacke. It is therefore first, second, and third. It is a good wall-stone and will resist a great heat. Millstones were quarried from Shawangunk Mt. (first graywacke) until the buhrstone manufactories were extensively introduced; and it was profitable to the manufacturers, and a public benefit. As they were wrought at Esopus (Kingston) in great quantities, they were long called Esopus Millstones. Ledges of Millstone grit, which would make tolerably good millstones, though liable to crumble, may be had in 2d graywacke near Utica, and in 3d graywacke on Alleghany Mountains.

Grindstone used in this country is a gray sandy variety of third graywacke. Two extensive layers of grindstone run nearly parallel to Schoharie Kill in Blenheim, Schoharie county, on the estate of Judge Sutherland. One range is in the west bank of the Kill, the other is further west. From pieces of rock adhering to Nova Scotia grindstones, I believe they are from the same rock. Numerous other localities of various qualities, are seen in the graywacke of Catskill and Alleghany Mts.

Whetstones, called novaculite, are always a variety of talcose slate. When they are harsh they are called Quinnebog whetstones, or scythe whetstones. When they are fine-grained they are called Turkey hone. They are wrought in Belchertown Mass., and at Lake Memphremagog in Vermont. Though these whetstones are always a variety of talcose slate, they are found in this country, at the meeting of talcose slate with mica-slate or argillite; when with the latter the whetstone is softer than when with the former. In Hawley, Mass. an inferior kind appears in connexion with the micaceous iron ore, at the meeting of the talcose slate and mica-slate.

Hones, of a very excellent quality, are found in first graywacke near a place called Red-Rock Pilfershire, in Columbia county, N. Y. and in Rensselaer-Ville, Albany county, in third graywacke. I have seen layers of the same rock in numerous localities in the third graywacke of Catskill and Alleghany mountain ranges.

USEFUL SALTS AND COMBUSTIBLES.

Table salt (muriate of soda) has not been found here in the solid state; but immense quantities of brine water issue from the red and grey saliferous rock, near the Erie Canal line, from twenty miles west of the city of Utica to the Niagara river. Pseudomorphous crystals, imitating those of muriate of soda, are found in the saliferous rock and in the liasoid, particularly near Manlius Center on the south bank of the canal. I have seen them 4 inches across, and very perfect.

Epsom salt is very common in the three graywacke ranges, in a state of efflorescence. A spring near Coeymans village is highly charged with it. It is produced on the exposed surfaces of the liasoid along the Erie canal—also on the marly clay of Coeymans, Lansingburgh, and other places in the vicinity.

Gypsum is chiefly confined to beds in the liasoid of the Erie Canal line and of the Western states; but it is found in smaller quantities in the saliferous rock. The snowy gypsum and selenite are found in geodes in the geodiferous limerock. Gypsum is, in truth, found throughout the whole of De La Beche's Red Sandstone group; but the quantity is very small, excepting in the liasoid.

Barytes is found to be very superior to borax as a flux in brazing and welding, when a very high heat is required. The native sulphate and carbonate are equally useful. Sulphate of Barytes is found in granite in the vicinity of Northampton for 20 or 30 miles north and south. Numerous other localities of the same kind are known. The lamellar kind is found in Calciferous sandrock along West Canada Creek, and near Little Falls; and spherical nodules are found in the saliferous rock at Genessee Falls. But it is found in immense quantities in Schoharie county, town of Carlisle, of the fibrous structure. It is in a soft slate rock, of the second graywacke kind, immediately beneath the Corniferous limerock.

Strontian is said to be a better flux for brazing and welding, than either barytes or borax, when an intermediate degree of heat is required. The sulphate of strontian is found in this country in Geodiferous limerock at Lockport, Niagara Falls, &c. Most abundant in the Geodiferous limerock of Strontian Island in Lake Erie. This locality was discovered by gentlemen employed in settling the boundaries between these states and Canada, in the year 1819; and was published by two of them as sulphate of barytes. One of the commission, William A. Bird, Esq., brought to Troy Lyceum 100 lbs. of it, all in beautiful crystals. I analyzed it in presence of the members of the Lyceum, detected the error, and it was published by order of the association. Afterwards several similar analyses were published.—*Carbonate of Strontian and Lime* (very vaguely described by foreigners under the name Arragonite) has been found to be an excellent flux--its excellence increases in the ratio of the proportion of strontian. In crystals it is found in small quantities in the Geodiferous limerock of Lockport, Niagara Falls, &c. But it has not hitherto been announced in any printed publication, which has come to my knowledge, in sufficient quantities to be used profitably by artists as a flux. A few days since, Mr. William Deere of Syracuse, (formerly my pupil, now a teacher) brought me twenty pounds of this mineral from Marcellus, Onondaga county, midway between Onondaga and Skeneatelas, and five or six miles south of a point on the Erie Canal 75 miles west of Utica. It is in connexion with Corniferous limerock, probably beneath it, and equivalent to Geodiferous limerock. Some specimens seem to contain a larger proportion of strontian, than any analyses of Arragonite have shewn. Its specific gravity ranges between 2. 75 and 3. 8—I have merely tested it by the purple flame; but I intend to make a thorough analysis soon, unless some one, who has more leisure, will do it. It appears that tons of it may be had. Pillars for a clock have been made of it, which may be seen in Syracuse, 3 inches in diameter.

Coal is found in four geological positions. First, *transition anthracite* which is found in beds in Argillite, in Newport, R. I. and in Worcester, Mass. It is found in very small layers along the Hudson River in the same rock. It is also disseminated in first graywacke in Rensselaer county. Second, *secondary anthracite*, which is found in exceeding small layers in second graywacke slate (in lower secondary class) near, and under, Utica, near Big Salmon river on Lake Ontario, near Cold Spring on the Mohawk &c. Third, *Coal proper*, which is found in large beds in Pennsylvania in third graywacke (in upper secondary class) also in small layers on Lakes Seneca, Cayuga, &c. It is bituminous in the western part of Pennsylvania, and anasphaltic in the eastern part. Fourth, *Lignite*, which is found in the clay of the tertiary class.

As all fossil coal and anthracite are now supposed to have been produced by the charring of vegetables; the science of mining, as applied to coal, is founded on a knowledge of the successive creations of families of vegetables, and of the alternating destruction of such families. From the fact, that marine and dry-land animals all disappeared at each period of the charring of vegetables, we infer that vegetables were charred by a degree of heat sufficient to kill every animal of the ocean as well as every animal and plant on dry land. The period of charring seems to be the dividing period between the Classes, or Series, of rocks, and between their accompanying species of organized remains; for no species appears to have survived one of these catastrophies, or even ever to have been re-created.

Brongniart says, that the examination and comparison of a great number of vegetable fossils of several epochs, have enabled him to recognize *four periods* of creation in that kingdom of nature; consequently four periods of charring them.

I. *First period.* Arborescent forests of the Equisetum and Filices (Rushes and ferns), much larger than those of the present day—also large plants, which combine the characters of the Lycopodium (ground pine) and Coniferæ (Pine, Hemlock, and Cedar trees) called Lepidendron. These plants, being charred, form the *Transition* anthracite in Argillite; as Newport, R. I. Troy, Waterford, &c.

II. *Second period.* A small number of small ferns, and very singular Coniferæ. These plants, being charred, form the minute masses of anthracite in Second graywacke slate near Utica, Cold Spring, Big Salmon river, &c., in the *Lower Secondary class.*

III. *Third period,* An immense quantity of Ferns, and still greater masses (though not so many species) of Cycadeæ; and the latter are more or less arborescent or dendritical. They combine the characters of the Ferns, and Palms. These plants, the Calamites, and some others, being charred, form most of the coal measures of Pennsylvania, and the great coal measures of Europe. This coal is in the *Upper Secondary class*, in third graywacke of North America. See Synonyms under the proper heads.

IV. *Fourth period.* Plants resembling those of the present day. They are often dicotyledonous. Charred, they produce the lignite. They are in the *Tertiary class.*

Sulphur is mostly found in combination with iron; and is called sulphuret of iron or pyrites. This ore is universally distributed. Sulphur is also found in combination with copper, lead, zinc, &c. Rarely found pure, excepting near volcanos.

USEFUL ORES.

Gold is found, often pure, in Talcose slate, in the Carolinas and Georgia; also in Mexico. Having discovered some of the southern gold adhering to talcose slate, I suggested the query, in Silliman's Journal, whether it might not be found in other places along this range of the same rock through the west part of New England. Dr. Emmons, has since told me, that Prof. Hitchcock has examined a locality of gold with similar associations with the gold of the Carolinas, in Somerset, Vermont. Also that it was sought and found in consequence of my suggestion. He added that Prof. Hitchcock would soon publish a short history of this discovery in the same Journal in which I made the suggestion.

Iron, in vast beds, occupies four distinct geological positions. 1. *Protoxid of iron*, often highly magnetic. It is chiefly confined to Gneiss ; as along the west side of Lake Champlain, in N. Hampshire, &c. &c. 2. *Proto-peroxyd.* or *Hematite*, of the colour of dark clotted blood. It is often stalactitic, and found among the ruins of talcose slate. If we could know that micaceous and specular iron ore had been fused at the time its talcose walls were broken down, we should say, that the stalactitic hematite was thus produced. Its best known locality is at Salisbury in Connecticut; but it is found along the west side of the Green Mt. range from Canada to Connecticut. It seems to be an indefinite mixture of the protoxyd and peroxyd of iron 3. *Argillaceous peroxyd of iron*, or *Reddle ore*, is mostly a soft red ore, consisting of clay and peroxyd of iron, yielding about 33 per cent of pure iron. It forms a layer in the ferriferous rock, over the saliferous rock, about a foot in thickness on an average ; and extends from near the city of Utica to near the west end of Lake Ontario. It is about 20 miles wide and two hundred and forty miles long. Such an extensive stratum has not been observed in any other place. 4. *Bog ore* is a regular deposite embraced in the Tertiary class. Its true central position is in marly clay, often associated with iron pyrites and lignite.—But it is often found in the marine sand, overlaying the clay. It is found in the tertiary sand and clay from Fort Ann near Lake Champlain to Coxackie, twenty miles below Albany—a distance of 80 miles along the west side of the Hudson River. It is found, also, in the tertiary deposites in the Highlands on the Hudson River, and among the high hills of New England, &c. &c.

Manganese, in the state of a peroxyd is found along the west side of the Green Mountain range from Connecticut to Canada. It is generally in the ruins of talcose slate ; and in one locality east of Great Barrington, Mass. I have seen it in place in the Talcose state where it meets the Gneiss. From these facts I am induced to believe that the original deposition of the manganese, was in talcose state. The subject has not been sufficiently investigated, however. East of Pittsfield, Mass. immense quantities of hematitic iron ore and some manganese are seen, serving as a cement holding together fragments of granular quarts rock, from the size of a pea to that of an ordinary school-house.

Lead is found in vast quantities along the Mississippi, probably in transition limerock—Bakewell's metalliferous limerock, or calciferous sandrock, perhaps. I have never seen fair specimens of the rock, which authorized a description ; but I have the opinions of respectable geologists. The ore from the Mississippi region is almost a pure sulphuret of lead, easily reduced. Lead ore is extensively disseminated in granite rocks near Connecticut river, in the region of Northampton. But the rock being very hard and the lead sparingly scattered through it, very little lead has been obtained with the expenditure of many thousands. Lead has been found in argillite and graywacke in Columbia county, also in Calciferous sandrock in Rensselaer and Montgomery counties, and various other places where this rock is found. But it is scarcely worth working.

USEFUL MINERAL WATERS.

The *Carbonated* waters of Saratoga, and of M'Culloch's Well in Albany, probably issue from Transition Agillite. *Sulphuretted* waters are co-extensive with soft rocks containing iron pyrites. Such springs are very common in Argillite, soft graywacke, filthy swamps, &c.

Sulphuric acid waters issue from the earth in various places in the town of Byron, county of Genessee.—The detritus from which they issue appears to be disintegrated Liasoid, containing minute fragments of gypsum. It is ash-grey, and contains an immense quantity of iron pyrites in exceedingly minute grains. The exposed surface of the little hillock, where it appears in the largest quantity, is strongly impregnated with the acid. On applying the tip of the tongue to the dry surface of apparrently charred turf, we seem to recognize purely concentrated sulphuric acid. Other springs in the vicinity, particularly one near Byron Hotel, flow in large quantities, sufficiently impregnated to coagulate the white of eggs. *Muriate of lime waters* are co-extensive with marly clay. Wells dug in this almost universal stratum, are highly charged with muriate of lime. *Deer licks*, or salt springs which attract deer and other animals, often contain no common salt in solution—being highly charged with muriate of lime only. I have seen a very noted *lick* of this kind in a thin stratum of marly clay resting on third graywacke, in Schoharie county.

ALPHABETICAL ARRANGEMENT OF GEOLOGICAL LOCALITIES.

Adams, Mass. Granular limerock in the valley and at the foot of the east Mt. Granular quartz on the side of the Mt. Black Hornblende towards the top opposite to S. Adams, Gneiss at the top, with veins of crystalline granite; these appear in boulders opposite to N. Adams.

Amboy Bay, South shore (being the north boundary of N. Jersey) is wholly tertiary. Bottom of the bank is plastic clay, overlayed with marley clay containing lignite coal, pyrites, &c.

Auburn, N. Y. Cherty limerock at and near the prison. Pyritous slate (Graywacke) containing a little bituminous coal, Liasoid or American lias.

Becraft Mt. near Hudson. Sparry and Shelly transition limerock, Graywacke.

Bellows Falls near Connecticut River, Vt. and N. H. Gneiss, Talcose slate near on the west—Argillite 2 miles west.

Berkshire Co. Mass. Talcose slate in vast mountains. Some of its layers are remarkably undulating. Some are convex upwards, Dewey. Some are concave upwards, Lee.

Bethlehem Caverns, 12 miles S. W. from Alany. Corniferous limerock abounding in stone-horns and hornstone. A slaty stratum, about 50 feet thick, separates it from transition limestone; which is second graywacke.

Black Rock, L. Erie. Cherty limerock, underlayed with Geodiferous Limerock. Here the Copper slate (Malachite slate, Kupferschiefer) is seen as a part of the Geodiferous stratum (Zechstien.) This cherty limerock extends to, and underlays, Pennsylvania coal.

Buffalo, on Lake Erie. Deep Deluvian from near the village to a considerable distance along the Canal towards Black Rock. The Village is underlayed by Graywacke and Cherty limerock. This graywacke is the same rock, which embraces the Pennsylvania coal beds.

Canandaigua, N. Y. Corniferous limerock. Along the Lake, 3d Graywacke rests upon it.

Carbondale, Penn. Vast beds of anasphaltic coal, in 3d Graywacke. It abounds in Vegetable fossils—such as NEUROPTERIS *elegans*, *acutifolia*, *auriculata*, *angustifolia* —the SPHENOPTERIS, *artemisaefolia*, *latifolia*, *trifoliata mantelli*, *&c*. The coal is not the transition anthracite, as at first supposed. Most of it is destitute of bitumen; but is an equivalent of the great coal-measures of Europe

Catskill, N. Y. On 1st Graywacke and Transition limerock. Here the Transition and Secondary limerocks meet; as may be seen along the banks of the Creek to Madison Village. But the numerous dislocations are calculated to confound the inexperienced.

Cattskill Mt. Chief of its mass is 3d Graywacke.—British geologists confound this coarse kind of rock with Transition Graywacke. Between this and our transition graywacke, are the Transition Limerock, 3d Graywacke, and Cherty Limerock. Also De La Bache's Red Sandstone group, in some localities. See P. 95. On the east face of this Mt. we see the Rubble, Millstone Grit, Red Conglemerate and Red Sandrock.

Cayuga Lake.—Corniferous Limerock forms its bed —3d Graywacke, its walls. The latter is remarkably interesting about Ithaca, at the head of the Lake.

Chesterfield, Mass. Gneiss, traversed by beautiful veins of crystalline granite, containing numerous and beatiful tourmalines.

Cohoes Falls on the Mohawk. Argillite of the clay slate kind, overlayed by the wacke kind.

Cold Spring, on the Erie Canal 8 miles east of Little Falls on the Mohawk. Here is the 2d graywacke slate, containing the Brongniartia carcinodea, Orthorcea conica —also a little anthracite.

Connecticut. No crystalline granite in regular strata. Mather.

Coral Cave on the Helderberg, 2 M. north of Pucker-Street.

Cummington, Mass. Mica-slate in perfection, containing actynolite, &c.

Dalton, Mass. Granular Quarts and limerock.—Three miles south of the village is most perfect granitic hornblende rock ; distinct in its geological relations from granite, as all rocks are which contain hornblende as a constituent.

Deerfield, Mass. Basalt, containing the calcedonic family, like other basalt.

Deerhill Highlands, N. Y. Zercon in iron ore embraced in gneiss. Mead.

Delaware River. Numerous vegetable impressions along its eastern bank, where the Delaware and Hudson canal runs.

East Rock, N. Haven, Con. Basalt, containing prehnite, &c. It rests on red sandstone. Scarcely columnar.

Eigteen-mile-creek, L. Erie. Third graywacke slate, containing bituminous slate, and minute specimens of coal ; being a continuation of the coal slate of Tioga, &c. Here are numerous remains of Terebratula spiriferoides.

Esopus Strand, on the west side of Hudson River, 96 miles from N. York, at the mouth of the Roundout and the entrance of the Hudson and Delaware canal. Here the transition and lower secondary limerocks run together and the undulated slate appears at the meeting of the argillite and first graywacke.

Flint Hill, ten miles west of Schenectady, on the Erie canal. The calciferous sandrock here contains coarse semi-opal, agate, &c.

Fort Plain, is a village at the mouth of Otsquago Creek. Here is most perfect birds-eye marble, half a mile south of the village. Ten miles south, on the same creek, is an immense quantity of Tufa, embracing an extensive cavern and five trees which have become a tufa substitute—here is, also, a burning suphuretted hydrogen spring.

Franklin, *Bergen Co. N. J.* presents perfect upper oolite. Horton.

Fryberg Ger. No Crystalline granite in regular strata, nor elsewhere on the continent. Borre & Webster.

Gas-port, near Oak-orchard creek.

Genesee Falls, present a beautiful natural cabinet of saliferous rocks, Ferriferous, and Liasoid; also, Geodiferous, on the the canal, containing limpid crystals of fluor-spar, waxy blende, &c.

Glenn's Falls, are transition limerock. Petrifactions found here are numerous; such as Lithodendron, Fungia, Columnaria, Turbinola, &c.

Goshen, Mass. Crystalline granite in veins, containing most beautiful tourmaline.

Halifax, N. Scotia. Basalt, and underlaying red and variegated sandrock, the same as at Palisados on the Hudson, Mt. Halyoke, &c. on the Connecticut. Alger & Jackson.

Helderber, a hill or mountain, chiefly in Albany county. It affords the most perfect Coral rag and Corniferous limerock, also grit slate and shell grit. Immense quantities or organized remains are found on its top and at its eastern foot.

Highlands, N. Y. No regular strata of crystalline granite. Mather.

Hoboken, opposite N. Y. city. Most perfect locality of Talcose slate, steatite, serpentine, and pure magnesia.

Holyoke, Mt. Basaltic mountain on the east side of Connecticut River, in Mass. near Northampton.

Hudson and Delaware Canal runs from Esopus Strand along the Roundout Creek, to Delaware River, thence to near Carbondale. It runs along the northeast side of Shawangunk forty miles.

Ithaca, head of Cayuga Lake. It presents vast perpendicular ledges of 3d graywacke of the pyritous slate kind. Falls of water, down these ledges, are stupendous, and keep the rocks clear for inspection.

Knox, on the Helderberg, is a township embracining Pucker-street village, and numerous localities of Coral rag, shell grit, &c.

Lakes, Northwestern (as Superior, Huron, &c.) are bounded on the northeast by a range of primitive rocks, which commence near Whitehall at the head of Lake Champlain. Pitcher & Day.

Little Falls, of the Mohawk on Erie Canal, 22 miles easterly from Utica. The rocks are Gneiss and Hornblende, with calciferous sandrock resting against both sides of the mountain—and Cal. Sand. is overlayed by Transition limerock.

Livingston Cave, on the Helderberg, near the top of a vast ledge is grit slate, and the slate is overlayed with Coral rag. This cave is about 4 miles east of Pucker-Street.

Lockport, on the Erie Canal about ten miles southeast of Niagara Falls. Here the canal is cut 31 feet deep for about two miles, through a Geodiferous limerock. The locks below are in a natural gorge in the slaty liasoid of a soft texture.

Macomb Mountains consist of several ranges of Gneiss and Hornblende rock, with intervening valleys of Calciferous sandrock, Transition limerock, and second gray wacke. It crosses the Erie Canal at Little Falls and Root's Nose; and extends by way of Ogdensburg along the northeast side of Lake Superior. It abounds in iron ore.

Madison Village, four miles N. W. from Cattskill Village. Here we see the Corniferous limerock resting on the Transition, and their undulations at meeting. Anthracite is found in the thin layer of 3d Graywacke slate, which is interposed in some places.

Manlius Center, on Erie Canal, 52 miles west of Utica. Very perfect Water Cement, or Liasoid, embracing beds of dark-coloured gypsum. Here is found pseudomorphous crystals of soft liasoid, imitating muriate of soda, 4 inches across.

Middletown, N. Jersey, along the south side of Amboy Bay. Remarkable locality of the Tertiary Formation containing lignite, amber, pyritous petrifactions, &c. In the Marly clay of the eastern part of the town, vast beds of Chlorite Chalk or Greensand are embraced.—The Greensand has been shown by Dr. Morton to be secondary, by the numerous organized remains contained in it; but the clay and overlaying marine sand are decidedly Tertiary. Such alternations, however, are common at the meeting of strata.

New Madrid in the Mississippi region, has trees still standing upright, which were sunk 30 feet by the earth quakes of 1812–13–20. The same earthquakes were felt 200 miles around. Bringier.

Newport, in R. Island. The anthracite here is genuine, and is embraced in Argillite. Vegetable remains or impressions are still common; though thousands have been taken away. Van Rensselaer.

Nine-mile-creek, on the Erie Canal, nine miles west of the salt works of Syracuse. Remarkable for the regular stratum of Shell marle, which commences on the canal a mile west of this place.

Northampton, on Conn. River in Mass. Remarkable as a central point in one of the earliest known and best mineralizing regions in the world. North America

Nova Scotia. See Halifax.

Oak-Orchard-Creek., on the Erie Canal, about 20 miles east of Lockport. Here the rock is Saliferous, red and gray. Specimens of great magnitude of the Encrinus giganteus are found in it—and in the gray kind numerous specimens of Lingula mytiloides are found. Twelve miles west on the same rock, there is a basin, called *Gas-port, through the waters of which carburetted hydrogen gas issues perpetually.

Oriskany, on Erie Canal, seven miles west of Utica. A mile west of the Village is a convenient locality for collecting Millstone grit; as large fragments have rolled down to the canal from the ledge.

Owego, on the Susquehanna River in Tioga county. The rock here is third graywacke. It contains numerous specimens of Encrinus tricyclus. Dr. Paige gave me the impression of a fern, found in the Hone-slate quarry at the foot of Tunkhannock Mt. That rock is a soft slaty layer of 3d graywacke which overlays the coal-measures. It is an Odontopteris; but is not figured by Brongniant. It resembles his Sclotheimii; but the bases of the leafets (pinnulae) are not connate. I intend sending it to Brongniart.

---

* This gas was first tested by myself and pupils while on a Natural history tour in 1826. It had previously been called sulphuretted hydrogen. We gave the place the name, Gas-port, which it still retains.

Otsego County has many of its high places covered with Corniferous limerock, which extends from Lake Erie. As this rock underlays the Pennsylvania coal, both at Carbondale and Tioga, Penn., I proposed an examination for coal in Otsego county, where slate overlays the limerock. I soon received several specimens of bituminous coal, thus situated. But like other similar localities in the state of N. York, the beds are too thin for profit.

Palisados, a name given to the Basaltic rocks on the west shore of Hudson river, commencing opposite to the upper part of the city of New York, and extending northerly thirty miles. The columns of basalt stand over Red sand-stone of the variegated kind; resembling the Saliferous rock of Genesee river. Between the columns and the sand-stone, there is generally an immense stratum of Trap-tuff, or basaltic Breccia.

Peru, Mass., east of Pittsfield. This is a mountain of Gneiss; being a continuation of the Green Mt. range.

Pine Rock, two miles north of N. Haven, Con. It is basalt, but scarcely presents the columnar structure. Some of this rock is exceedingly coarse. It is used in N. Haven as the most common wall-stone.

Pittsfield, Mass., its western boundary is the east line of New Lebanon in the state of N. York. It is situated on Granular limerock. Near the village is a fine deposite of shell marl. Two or three miles east, the talcose slate crosses the Boston road.

Platterkill, crosses the Erie Canal 35 miles west of Schenectady. Its bottom is Calciferous sand-rock, its walls Metalliferous limerock, near the canal. From one and a half miles to two and a half, the bottom is the same second graywacke as at Cold Spring. I found anthracite coal in it, in very thin masses.

Pucker Street, (a nickname at first, but now established by custom,) is a small village on the Helderberg, 22 miles southwest from Albany; very interesting to the geologist. It has been the central resting place for geologists from the year 1817. They put up at this place for the purpose of collecting organized remains in the vicinity. Two miles north is Coral Cave—the cover of which is Coral rag, and the bottom and sides are grit slate. Half a mile east is the shell grit. Along the north of the village is Corniferous limerock. Four miles east is Livingston Cave.

Rondout Kill, empties into Esopus Strand, three miles north of Kingston, at the entrance of the Hudson and Delaware canal. At the entrance on the left hand is the undulating slate. Five miles up the genuine Clay-slate Argillite appears. Ten miles up is the Fall, where the Millstone grit of Shawangunk comes to the Creek and passes under the red sandstone. It resembles the grey-band of Genessee river in some places. It is overlayed by a limerock, which supports what appears to be a liasoid, and is successfully used as a water cement. Over the liasoid lies the Corniferous limerock. But the latter rests immediately on the lower limerock often.

Root's Nose, is a high bluff in the town of Root, on the south side of the Erie canal, 34 miles west of Schenectady. It is Calciferous sandrock, and embraces a cavern (called Root's Nostril) 400 feet in extent. Near it, on the east side is a lower prominence of Gneiss.

Sable, *Maryland*, Messrs. Troost and Finch, found amber in lignite, in the Tertiary formation.

Salmon River on Lake Ontario, runs many miles through Second Graywacke. This is the same rock which overlays the transition limerock of Trenton Falls, and on which Utica stands. It abounds in petrifactions about four miles from its mouth where it empties into Lake Ontario.

Salisbury, *Con.*, a remarkable locality for stalactitic hematitic iron ore, imbedded in the ruins of talcose slate.

Saratoga, in Saratoga county, 30 miles northwest of Troy, N. York. The strongest natural carbonated waters in the world issue, probably from the argillite, throughout a distance of country containing about 100 square miles.

Shawangunk, or the White Mt. in Ulster and Orange counties, on the west side of the Hudson, in N. Y. It is more than 40 miles long, and is most perfect Millstone grit. It is a continuation of the Grit and Rubble of the 1st Grawacke of Rensselaer county.

Sing Sing, on the east side of the Hudson, below the Highlands. Alternations of Gneiss, Granular quartz, Granular limerock containing copper pyrites, and Argillite. Statuary marble is here manufactured by the prisoners of the State Prison.

Skenando Creek. The Corniferous limerock of Lake Erie has been traced to this Creek. Geddes. This Creek passes Hamilton College, ten miles southwest of Utica.

Skeneatelas Lake has its banks partly of Corniferous limerock, containing numerous specimens of the Cyathophyllum (stone-horn).

Somerset, Vermont, has a rock of talcose slate, containing gold.

Spraker's Basin, is on the Erie canal, 36 miles west of Schenectady. On the north side of the Mohawk, opposite to the Basin, is a high ledge of Calciferous sandrock. It contains semi-opal, quartz crystals containing anthracite, agate, &c.

Starch-Factory-Creek, has a fall five miles south of Utica, where the second Graywacke slate and Millstone grit meet in a manner which is very instructive.

Stevens-Mills, in the west part of Coeymans, in Albany county, presents an excellent view of the layers of 3d Graywacke, containing layers of petrifactions.

Strontian Island, in Lake Erie, contains the largest and most numerous crystals of any place hitherto described, of sulphate of strontian.

Syracuse, on the Erie Canal, 61 miles west of Utica, stands on Saliferous rock, red, grey, slaty and sandy.

Taughconnuk Mt., at the southwest corner of Massachusetts. It is Talcose slate, with some veins of granite; and, in some places, an aggregate resembling gneiss.

Tioga Coal-beds, though bituminous, are in the same geological deposite with the anasphaltic coal of Carbondale. . In several places they approach very near each other, and, probably, will be found to pass into each other. All these beds are in third Graywacke slate.

Trenton Falls, 14 miles north of Utica, consist of shell limerock of the Transition class. The numerous petrifactions are the same as those of Sackets Harbor.

Troy, N. Y., stands chiefly on Diluvion, surrounded on all sides but west by Tertiary hills. The first graywacke, which is quarried here, is much traversed by calc spar, and contains disseminations of anthracite. Argillite, often containing satin spar, is the underlaying rock; and at the west ferry the rock is silicious slate.

Utica is a city in Oneida county, N. York, about 96 miles west of Albany, on the Mohawk. It is situated on second graywacke slate. Erie canal runs through near the center of the city.

Van Schaack's Place. This is merely an obscure tavern, on the road from Bethlehem Caverns to Puckerstreet. But it is necessary to refer the student to this place, on account of the numerous petrifactions to be found near it, in Corniferous limerock. It is between three and four miles northwest of Bethlehem Caverns. Several species of Cyathophyllum are found near this tavern, particularly the C. helianthoides, &c.

Westfield, Mass. Four miles west of the Academy is a locality of serpentine and talc, embraced in Gneiss. This is similar, in all respects, to a locality in Savoy, Mass., on the Mt. east of South Adams. These deposits have no connexion with Talcose slate or steatite.

West Point, in the Highlands, on the west side of the Hudson, has its Military Academy on Gneiss, with alternations of coarse beds of Graphic granite, and Hornblende. These rocks are well described by Mather.

West Rock, N. Haven, Con., is basaltic and somewhat columnar. It is of the coarse kind and breaks naturally into good wall-stone.

Williamsburg, *Mass.*, is remarkable for its pseudomorphous quartz crystals, and its argentine.

Williamstown, *Mass.*, embraces Gneiss, Talcose slate, Granular quartz, Granular limerock, sparry limerock, and Argillite. Also localities of Tertiary and Diluvial deposits.

Worcester, *Mass.*, has argillite in view on the east and west sides of the village. Two miles east the Argillite embraces a thick vertical bed of anthracite. Talcose slate comes in contact with one of its sides, and Gneiss with the other. I traced this range of Argillite to Providence, by inferring its continuity from distant points of its appearance. Anthracite was found in a well in this rock in Providence. Newport, probably presents the same range.

Zanesville, Ohio. Coal formation same as at Carbondale, though bituminous. This appears from Granger's finding the Sphenopteris dubuissonis there, which is also found at Wilksbarre, &c.

Remark. It was my intention, as I signified in an introductory article, to have selected from the labors of our geologists four fold the materials here presented. But after I had completed the preceding parts of the Text-Book, I received notice, that a sixth edition of my Botany was called for ; which will occupy all my spare hours for the present. Most respectfully I solicit materials from American Geologists, for extending this article in my next edition. I beg that they may be very particular, that I may select and digest in my own way.

NOTE.—Since the above was in type, Mr. Mather has authorised me to add to the article, *West Point.* Talcose slate, common and chloritic, run along the southeast base of the Highlands—Gneiss farther east. The Granular limerock of Canaan, Con., crosses the same southeast course in Danbury. Next, most perfect Porphyritic gneiss in Bethel and Redding. A. E.

PLATE. 1. See pp. 36, 37.

4. ENCRINUS *curvatus.* I find nothing in Miller, not in any work in my possession, to which this can be referred. It is probably new. Found at Glenn's Falls. It bears a remote resemblance to Miller's Encrinus moniliformis in some parts of its column.

5. ENCRINUS *transversus* (Poteriocrinitus crassus, Miller.) Found in Conybeare's encrinal limerock, birdseye marble, at Otsquago Creek, &c.

11. E. *transverus, variety multiradiatus.* It is wrongly described as a distinct species at p. 36. At the same place it is wrongly referred to 2d graywacke; for the rock near Niskeuna, in which it is found, is first graywacke. Thus the same species is found in two of the transition rocks.

6. E. *tricyclus* (Encrinitus moniliformis, Miller.) Found in third graywacke at Owego.

7. E. *equicyclus* (Actinocrinitus laevis, Miller, in Fig. 15, 16.) Whorls equal, thick and prominent. Found in Corniferous limerock at Bethlehem Caverns. Miller must have confounded two distinct species—this and my teretiformis.

8. E. *giganteus* (Probably the E. ramosus of Sclotheim.) Found in Saliferous rock at Oak-Orchard-Creek, on the Erie Canal, under all our basalt, and on Catskill Mt., &c.

9. E *interruptus* (Actinocrinitus dactylis? Miller, in pl. 6. Fig. 3, 9.) Found in Coral rag at Coral Cave.

10. *Pentacrinus fimbriatus* (P. caput medusæ, Miller.) It appears p. 55, that Miller was inclined to consider this a new species. Found in First Graywacke near Niskeuna, not 2d.

12. *Encrinus teretiformis* (Actinocrinitus laevis, Miller, Fig. 12. 34.) In Coral Cave. I think Miller must have confounded this with my equicyclus and his dactylis.

1 *Asaphus selenurus.* This figure is too flat, and not well proportioned.

2. NUTTAINIA *concentrica.* The dotted fillet of the left-hand figure is too high an arch and not wide enough: it is better proportioned in the right-hand figure. The last figure represents it in its contractile state, as it is sometimes found in Waterford argillite.

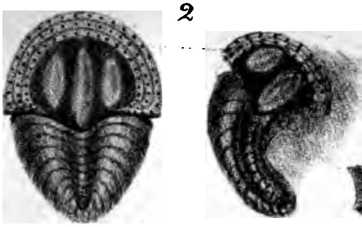
3. BRONGNIARTIA *carcinodea.* 13. FLUSTRA carbaseoides.

14. SARCINULA *ramosa.* 15. ALCYONIA *fungioides.*

16. ECHINUS *gyracanthus.* The body is rarely found perfect; but the whorls of the spines are decisive. It is found in the bluest kind of Corniferous limerock, and in an alternating graywacke rock, which lies upon the limerock, near Bethlehem Caves, and in Coeymans.

1

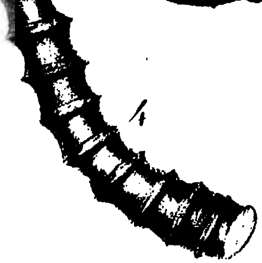
2



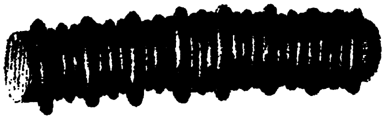
3

5

4

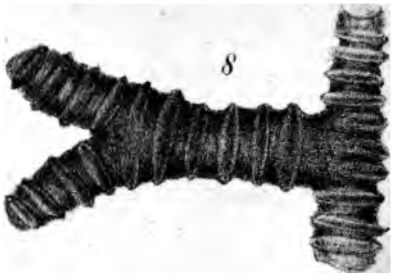


6

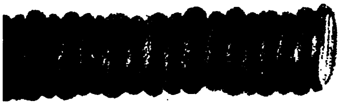


7

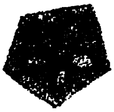
8



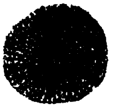
9



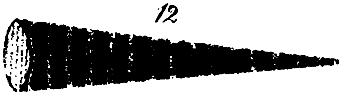
10



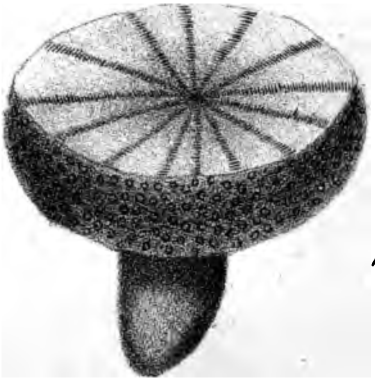
11



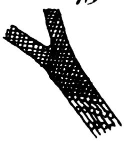
12



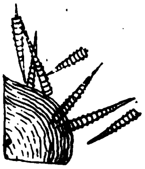
15



13

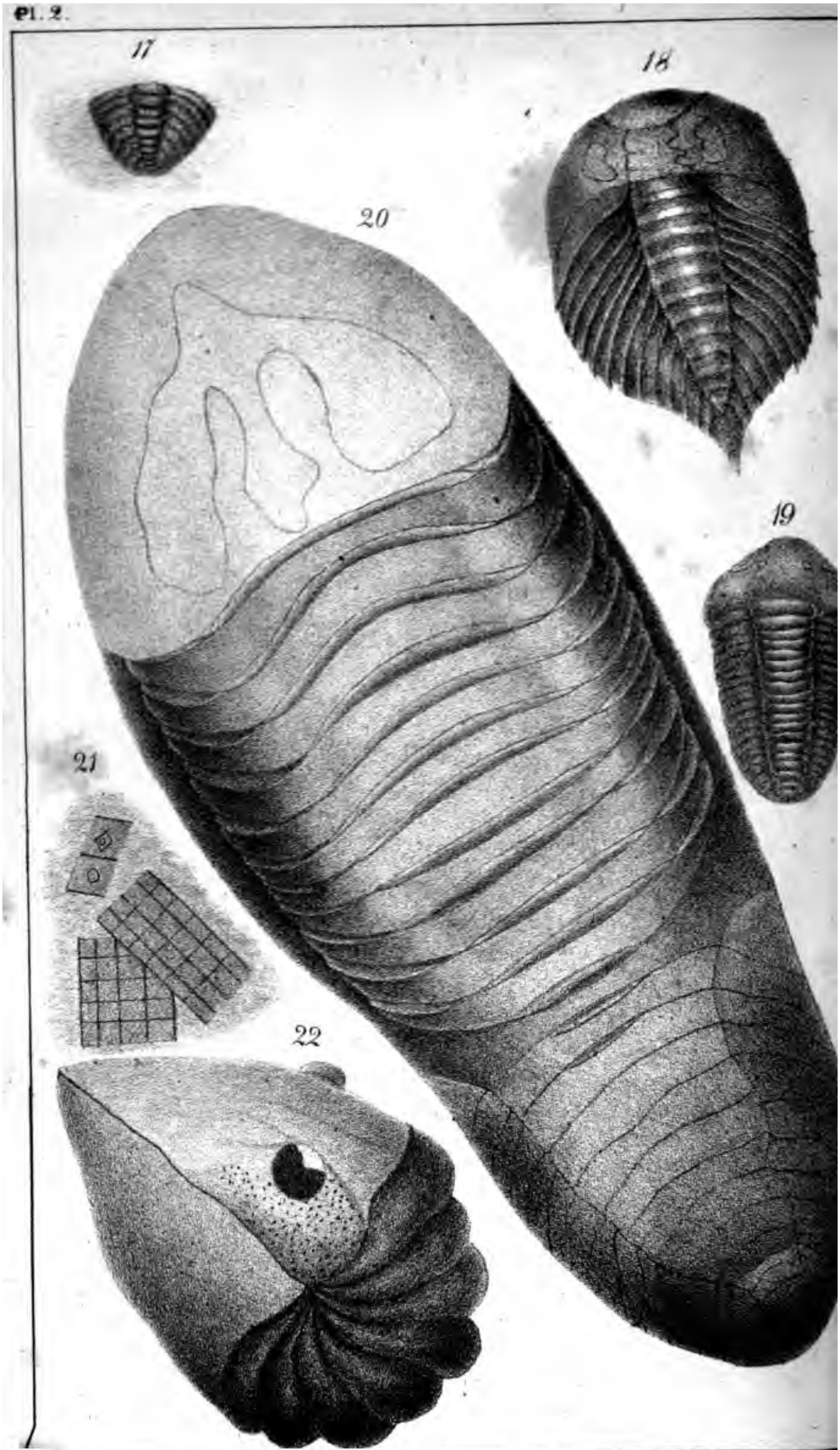


16



Lith. of Pendleton, N.York.

Pl. 2.



Lith' of Pendleton, N.Y.

On Stone

PLATE 2.

17. Asaphus *hausmannii.*

18. A——— *caudatus.*

19. Calamena *blumenbachii.*

20. Brongniartia *platycephala.*

22. B——— *isotelea.* In this figure the animal is contracted, or one half folded upon the other. The B. carcinodea is found in the same situation. A living species, found at Cape Horn by Dr. Eights, which resembles the B. carcinodea, puts itself in the same position on being disturbed.

21. Coscinopora *sulcata.* This figure is not intended to give the form of the petrifaction. It gives a piece or patch from its surface, exhibiting, correctly, its checkered outside. The enlarged two squares exhibit the orbicular opening only in the lower square, and the rhomboidal inner opening in the upper square. We are supposed to see through the outermost covering where we see the inner rhomboidal opening.

PLATE 3.

23. ORTHOCERA *undulata.*

24. O——*annulata.*

25. O——*conica.*

26. O——*striata.*

27. O——*circularis.*

28. O——*paradoxica.*

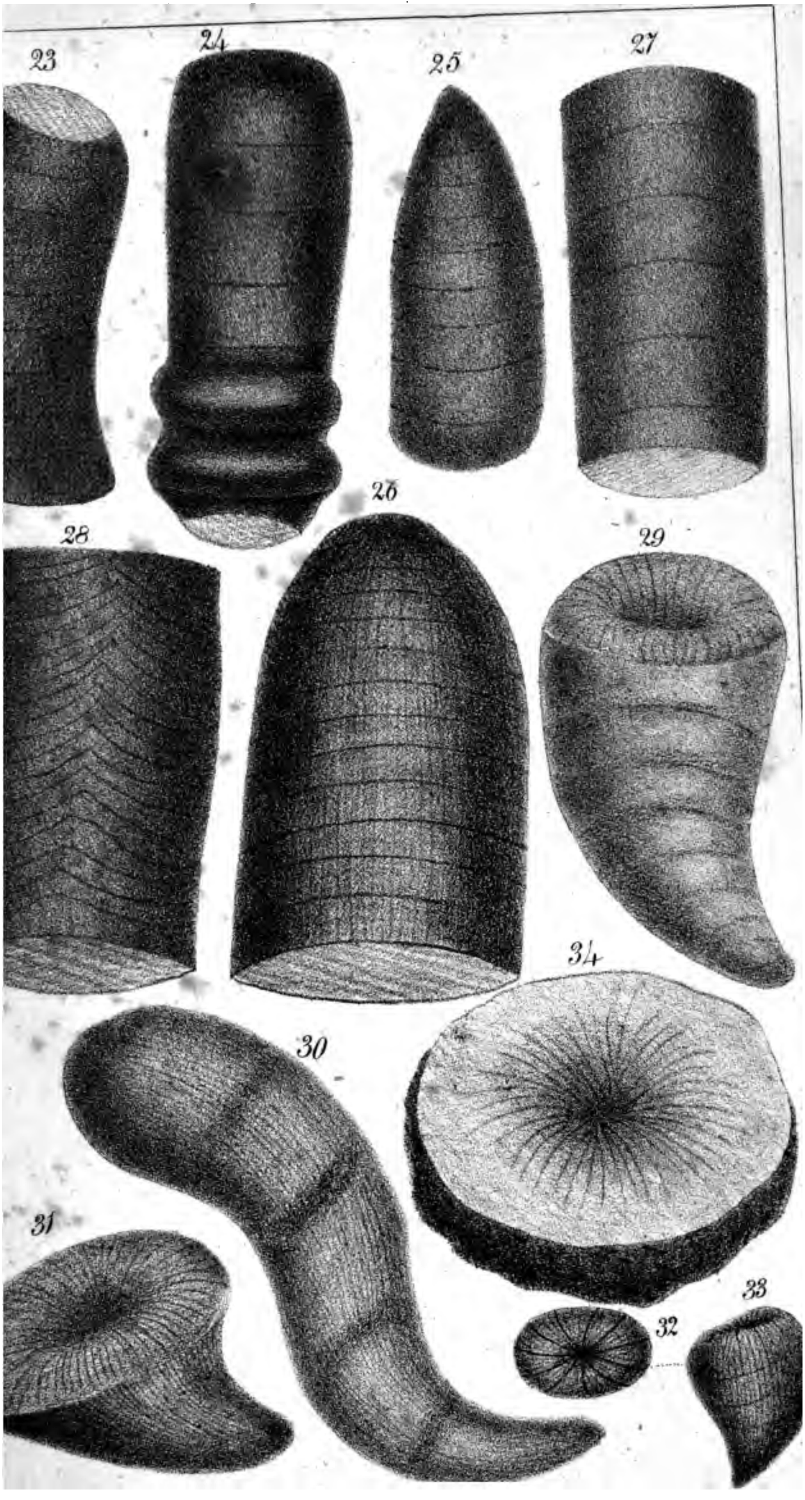
29. CYATHOPHYLLUM *ceratites.* This is the most common of all the species, and well characterizes the Corniferous limerock.

30. C——*flexuosum.*

31. C——*helianthoides.* Very abundant near Van Schaack's. This is the solitary kind.

34. C——*hypocrateriformis.*

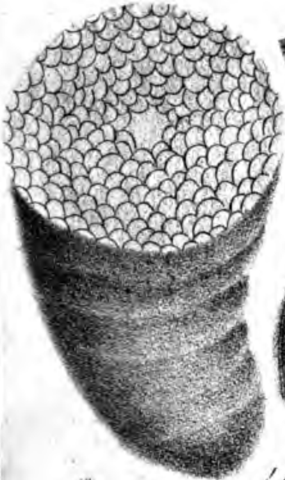
32 and 33. TURBINOLA *mitrata.* The Fig. 32 is an exhibition of the radiated or stellated disk.



Lith' of Pendleton NY

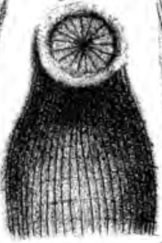
On Stone

35

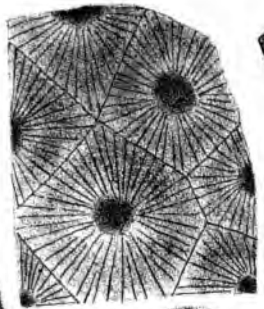


36

37



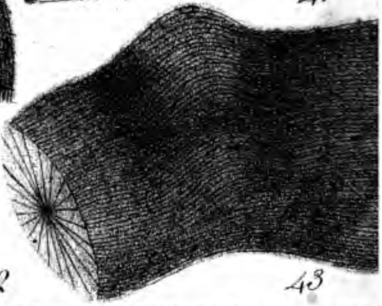
38



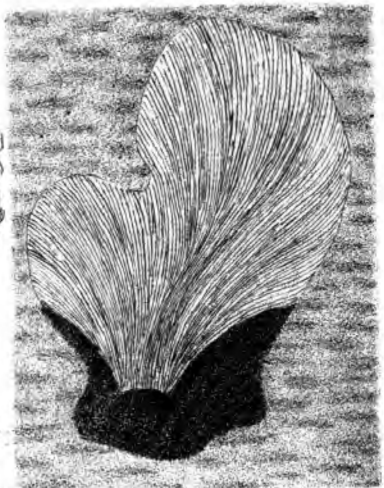
39

40

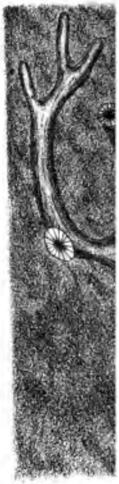
41



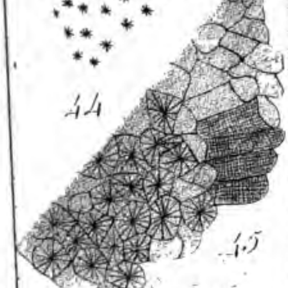
42



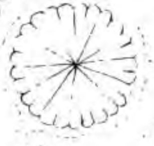
43



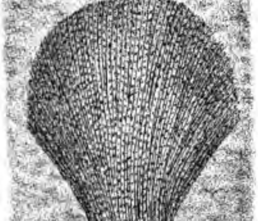
44



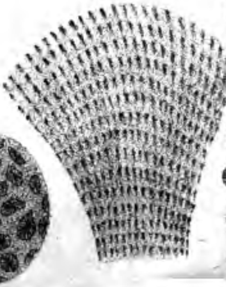
45



46



47



48

Lithy of Pendleto

PLATE 4.

35 & 36. CYATHOPHYLLUM *vesiculosum*. The 36 represents a vertical section near the apex of 35.

37. C. *hexagonum*.

38. *helianthoides*. Abundant near Van Schaack's. This figure represents the ends of the cespitose kind.

39 & 40. ASTREA *porosa*. The fig. 40 represents the outer sub-spherical side covered with little stars and some pores. The fig. 39 represents the inner side when broken. Both figures are only sectors of circles; as the whole is sub-spherical.

48. A. *stylopora*. Both species found on the south shore of Lake Erie. This in the slate, and the other in the pyritous calcareous grit. It is all in the Oolitic series, without oolite.

41. CYATHOPHYLLUM *vermiculare*. This figure is not accurate; the transverse ridges are not deep enough. It should appear as if larger and smaller pieces were joined, where the shaded ridges are. It is rather larger than we generally find this species; and not sufficiently jointed in appearance.

42. DIPLOCTENIUM *pluma*.

43. LITHODENDRON *dichotomum*. Numerous such branches are often found with interlocking limbs.

44 & 45. COLUMNARIA *alveolata*. I am not sure but this may be a variety of the Calamopora alveolaris of Goldfuss. In truth I have not yet been able to settle the distinctions between these two and the Calamopora favosa (which latter we usually call Favosite), among our specimens. This fig. represents a segment from the side of a circular specimen. The fig. 45 represents the stellate termination of the tubes. It is by these that students must settle the characters of these apparently similar petrifactions.

46. GORGONIA *infundibiliformis*.

47. G. *ripisteria*. Both figures are too stiffly circular. Goldfuss has given a second figure of No. 16, and further explanations, in his second number.

Plate 5.

50. **Bellerophon** *cornu-arietis.* We have two species not figured; but they are easily determined by the descriptions after seeing one.

51. **Columnaria** *sulcata.* The C. *intermedia* is easily distinguished after seeing the sulcata, without a figure.

52. **Madrepora** *limbata.* I am not sure but this may be an Astrea.

53. **Catenipora** *escharoides.* 54. **Retepora** *disticha*—magnified.

55 & 56. **Fungia** *discoidea.* The fig. 55 is the flat upper side, and the 56 is the convex under side. Both are sectors of circles.

61 & 62. F. *polymorpha.* The fig. 62 is a truncated sector from the upper convex side, and the 61 is the whole flattish under side.

59 & 60. **Coscinopora** *macropora.* The fig. 59 is part of an irregular surface, and 60 represents three pores magnified.

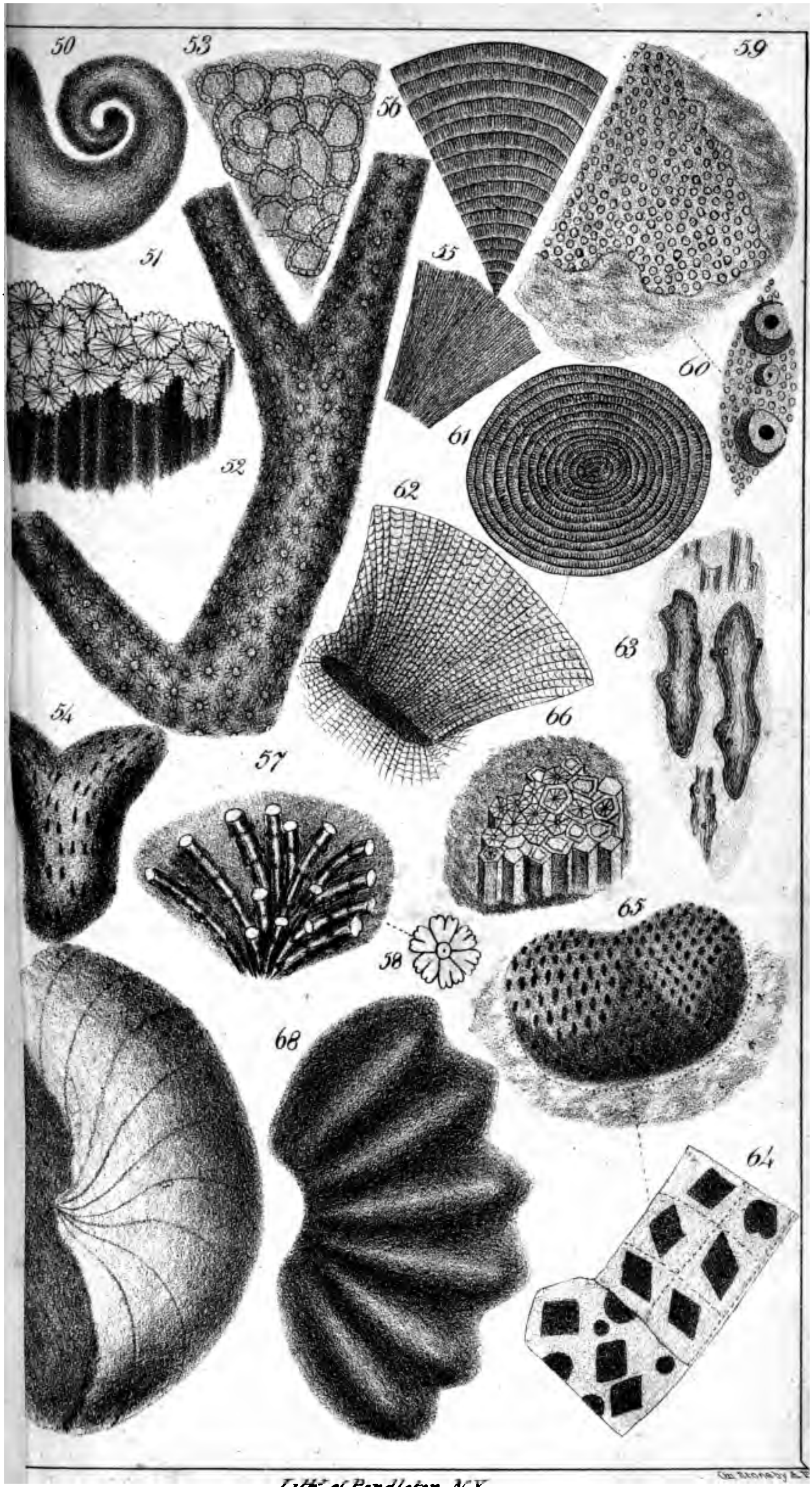
63. **Syringopora** *verticillata.* 66. **Cyathophyllum** *quadrigeminum.*

57 & 58. **Sarcinula** *micropthalma.* The fig. 58 represents the stellated ends of the tubes. The tubes in this figure are too stiffly cylindrical. In this respect they are intermediate between those represented here, and those better drawn on Plate 1, fig. 14, for the S. ramosa.

64 & 65. **Coscinopora** *infundibiliformis.* The fig. 64 represents the rhomboidal and small circular pores, enlarged. This figure was drawn from an excellent specimen, four inches across; but want of room has rendered the figure too stiff.

67. **Nautilus** *imperialis.* Outside shell well preserved; also exhibiting the inside in part, which is green-sand.

68. **Same**, it is wholly a natural inner casting of green sand. Both were found in the New Jersey tertiary, into which the chalk formation is often protruded. The green-sand, or chloritic chalk, only, is ever found embraced in, or alternating with, the tertiary clay. It is never found in the sand, excepting where there is conclusive evidence of modern, or diluvial, displacement of the sand.



Lith. of Pendleton N.Y On Stone by A. F

INDEX.

Analysis of soils 102 105
Anomalous deposits 85
Articulata 30 34
Beds of rivers and lakes 11
Creation 47
Crinoidites 35 37
Cyathophyllites 37
Deposits 48 61
Fungites 42
Gorgonites 43
Helicites 29
History of geology 12 24
Internal heat 9
Localities, alphabetical 115 125
Madreporites 39
Mining 105 114
Mollusca 27 30
Nautillites 27
Ores 111 113
Organic remains 25 46
Plates and descriptions 127 132
Proofs of series 87 92
Quarry stones 106 108
Radiata 35
Reasons for names 92 96
Reteporites 43
Salts 108 109
Section figures 56 59
Series and formations 63 67
Soils 97 102
Springs 113 114
Strata described 68

Do. primitive 68
Do. transition 72
Do. lower secondary 76
Do. upper secondary 79
Do. tertiary 81
Do. subordinate 82
Subordinates explained 66 67
Synoptical figures 63
Trilobites 30
Tubiporites 40
Weight of the Earth is about six thousand million of millions of millions of tons, or more accurately 5,920,000,000,000,000,000,000.
Its specific gravity 5 9
York, New, Geological map of. It is now folded in a case and sold separately. It was corrected, on the 15th of May 1832, so as to present all the improvements set forth in this edition. To the explanations on the map it may be added, that No. 1 of the Carboniferous formation should be a lighter slate color than the other numbers; it being the primitive, this distinction is important.

BRANNER
EARTH SCIENCES LIBRA

550 .E14 C.2
Geological text-book, for aidi
Stanford University Libraries
3 6105 032 199 023

55C
E14
ed. 2
cop. 2

Stanford University Libraries
Stanford, California

Return this book on or before date due.

Gregory